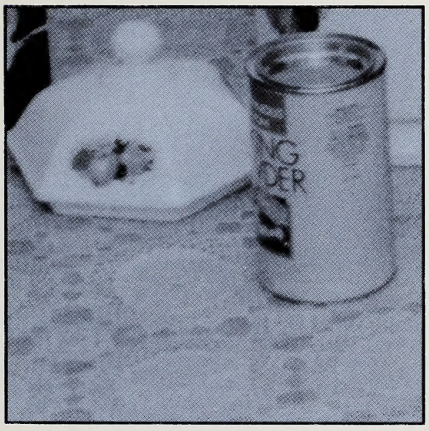
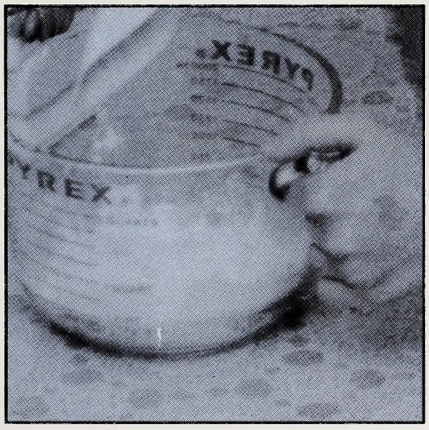
SCIENCE 14

MODULE 6: HOUSEHOLD PRODUCTS AND REACTIONS





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Distance Learning

Alberta EDUCATION

Science 14

Module 6

HOUSEHOLD PRODUCTS AND REACTIONS

Science 14
Student Module
Module 6
Household Products and Reactions
Alberta Distance Learning Centre
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Welcome to Module 6!

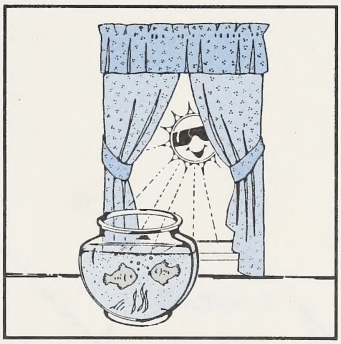
We hope you'll enjoy your study of Household Products and Reactions.

To make your learning a bit easier, a teacher will help guide you through the material.

So whenever you see this icon,

turn on your audiocassette and listen.

Contents

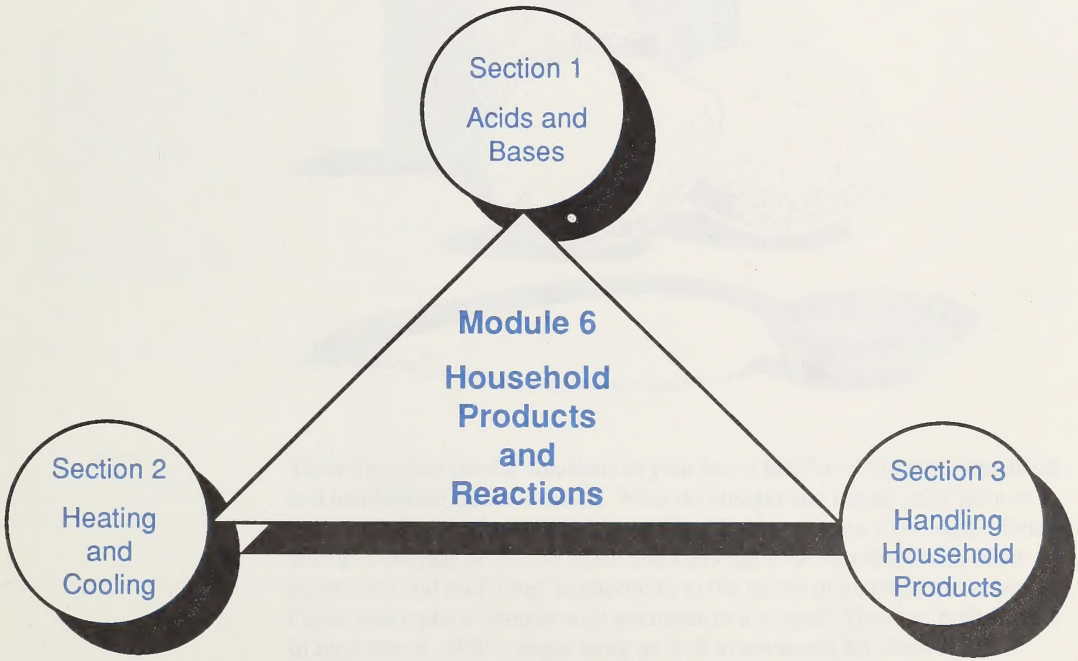


SECTION 3:

OVERVIEW

Many people use things in the home or garage without really knowing how they work. This lack of knowledge can lead to dangerous situations. Knowing the contents of household products and understanding how the products work is important to the safety of both the home and its occupants.

In this module you will learn about the differences between acids and bases and what happens when they are put together. You will also learn about how heat is transferred and how the knowledge of heat transfer must be used when manufacturing appliances and products for the home. Finally, you will examine different household products and processes to understand how special care must be taken when using certain products in and around your home.



Evaluation

Your mark in this module will be determined by your work in the Assignment Booklet. You must complete all assignments. In this module you are expected to complete four section assignments. The assignment breakdown is as follows:

Section 1	=	30 marks
Section 2	=	30 marks
Section 3	=	40 marks
TOTAL	=	100

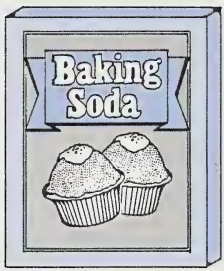
1 Acids and Bases

There are some special solutions in your home that have common properties and identifiable characteristics. What do vinegar and lemon juice have in common? Do you know how soap and milk of magnesia are related? Being able to recognize acids and bases and knowing how they react with other substances and each other is important to the safety of yourself and others. Could you replace vinegar with ammonia in a recipe? They are both similar in appearance. Will vinegar work as well as ammonia for cleaning the kitchen floor? By the end of this section you will be able to answer these questions because you will have learned about the identification, properties, uses, and reactions of acids and bases.

Activity 1: How Do Acids and Bases Act?

How would you describe the taste of a lemon? Sweet? Sour? Bitter? While there may be a variety of answers from different people, the majority of people will say that lemons taste sour. All acids taste sour. Therefore, lemons must contain an acid which gives them their sour taste.

How would you describe the taste of baking soda? Bitter? Bland? Salty? Different people may describe the taste of baking soda in different ways, but the taste would generally be described as bitter. All bases taste bitter. Therefore, baking soda must contain a base which gives it a bitter taste.



Some people use baking soda instead of toothpaste to brush their teeth. Do you?

Caution: Taste is only one way to tell if a substance is an acid or a base. **Never** taste chemicals which are not used for food. They could be poisonous.

Investigation: Household Acids and Bases

WESTFILE INC.

Materials You Need

Acids

- lemon juice
- vinegar
- pickle juice
- cream of tartar
- aspirin

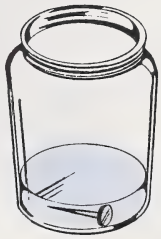
Bases

- baking soda
- antacid tablets
- bleach
- window cleaner
- liquid soap
- 30 mL cooking oil
- six small jars
- six small nails (uncoated)
- spoon
- litmus paper
- one test tube
- one rubber stopper
- masking tape

Steps to Follow

STEP A

Select any three acids and any three bases from the list of materials. Use masking tape to label a jar with the name of one of the selected acids, then add about 25 mL of that acid to the jar, and place one nail into the acid. Repeat this process for the remaining acids and bases until all six jars are correctly labelled and contain one acid or base and a nail. Put the jars in a safe place away from children. Inspect the jars after 2 days, looking closely at the nails. Record your observations in the step A observation chart.



STEP B

Select any three acids and any two bases from the step B observations chart. Taste a small amount of each and record the taste as sour or bitter.

STEP C

Test each of the substances listed in the step C observations chart with litmus paper. Litmus paper is an **indicator** that changes colour in an acid or a base. Litmus paper turns red in an acid and blue in a base. Dip the litmus paper into each of the substances and record your observations. To test the solids, dissolve them in a little bit of water.

Indicator - a chemical that changes colour in an acid or a base

Caution: Never taste anything that is not food. An exception may be hand soap. (Have you ever had your mouth washed out with soap?) If you are going to taste soap, rub your finger on a bar of soap and then lick the finger with your tongue.

One teaspoon holds about 5 mL of liquid.

STEP D

Rub a small amount of each substance listed in the step D observations chart between your fingers. Record your observations of how each substance feels. To test the solids, dissolve them in a little water. Wash your fingers well after each test.

STEP E

Put about 1 mL of cooking oil into a test tube. To the oil add about 10 mL of a substance from the step E observations chart. Solid substances should be dissolved in 10 ml of water. Stopper the test tube and shake well . Record whether the oil dissolved or not. Repeat this process for each substance in the chart.

Observations

STEP A	Name of Acid or Base	Appearance of Nail after 2 Days
Acids		
Bases		

STEP B		Taste
Acids	lemon juice	
	vinegar	
	pickle juice	
	cream of tartar	
	aspirin	
Bases	baking soda	
	antacid tablet	
	soap	

STEP C

Substance	Litmus Colour	Acid or Base
lemon juice		
vinegar		
pickle juice		
cream of tartar		
aspirin		
baking soda		
antacid tablet		
soap		
bleach		
window cleaner		
liquid soap		

STEP D

Substance	Feel
lemon juice	
vinegar	
pickle juice	
cream of tartar	
aspirin	
baking soda	
antacid tablet	
soap	
bleach	
window cleaner	
liquid soap	

STEP E

Substance	Oil Dissolved (yes or no)	Substance	Oil Dissolved (yes or no)
lemon juice		antacid tablet	
vinegar		soap	
pickle juice		bleach	
cream of tartar		window cleaner	
aspirin		liquid soap	
baking soda			

Conclusion

1. Acids taste different than bases. Make a general statement about the tastes of acids and bases.

_____

_____

2. Acids and bases differ in their reactions with metals. Make a general statement about how acids react with metals and how bases react with metals.

_____

_____

_____

3. Litmus paper changes colour in acids and bases. Make a general statement about the colour of litmus paper in acids and bases.

_____

_____

4. Acids and bases feel different. Make a general statement about the feel of acids and bases.

_____

_____

5. Acids and bases react somewhat differently to oils. Make a general statement about the ability of acids and bases to dissolve oil.

_____

_____

Check your answers by turning to the Appendix, Section 1: Activity 1.

neutral - neither acidic nor basic

Test ordinary tap water with litmus paper. You may find that your tap water is **neutral** or slightly acidic. If it was very acidic it would tend to corrode your water pipes. This is actually a problem in areas which get water from lakes and streams that have been acidified due to acid rain. You might want to try neutralizing some of the food acids in the previous investigation with baking soda.

Caution: Neutralization of acids and bases releases heat and vapours which may be harmful. Never mix household chemicals. Never store household chemicals in containers which have contained other chemicals.

Activity 2: Warning! This Contains...

It is important to be aware of the dangers of certain substances. It is also important to know how to handle dangerous substances. Your health and safety could be at risk if certain harmful substances are used improperly. Your health and safety can also be at risk if certain common household products are used improperly. Most household acids and bases have warning labels on the containers which explain the dangers of the products and how to deal with accidents involving the products.

Read the labels of common household bases such as drain cleaners, oven cleaners, bleach, window cleaners, tub and tile cleaners, floor cleaners, soaps, fertilizers, antacid tablets and liquids, baking soda, and any others that you can find.

WESTFILE INC.

1. Do all bases have warning labels? Explain.

_____

_____

_____

2. Are all bases harmful?

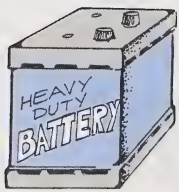
_____

_____

_____

3. Draw some of the symbols that are found on the labels and explain the meaning of each symbol.

Now read the labels of common household acids such as vinegar, lemon juice, cream of tartar, shampoo, aspirin, and any others that you can find.



4. Do all acids have warning labels? Explain.

5. Are all acids harmful?

6. Draw some of the symbols that are found on the labels and explain the meaning of each symbol.

7. What types of substances in your home are bases?

8. What types of substances in your home are acids?

Check your answers by turning to the Appendix, Section 1: Activity 2.

Activity 3: pH

Have you seen a television commercial that advertises pH balanced shampoo? Maybe you use special paper to make sure that the pH of your fish tank is suitable for your fish. Farmers check the pH of the soil to see if it needs to be treated so the crop they plant will grow better. Almost every day you hear about pH or something being pH balanced. What does pH mean?

pH - a measure of how acidic or how basic a solution is

There are times when it becomes important to know how acidic or basic a substance is; **pH** is a measure which tells you just that. A pH measurement does not really tell you how strong an acid or a base is, but it does tell you how concentrated the acid or base is. If you are comparing acids and bases that are at the same temperature and concentration, then the pH measurement will indicate the strength of the acid or base. The following investigations should help you understand more about pH.

Recall that litmus paper turns red in an acid and blue in a base. Similarly, pH paper also changes colour for different pH values.

To find the pH of a substance dip a piece of pH paper into a small amount of the solution to be tested. Then compare the colour of the paper to the colours shown on the container. When you find the best match of colour, read the pH above the colour. This is the pH value of the solution.

Investigation: Finding pH Values

Materials You Need

- pH indicator paper
- spoon
- orange or lemon juice
- pickle juice
- vinegar
- soda pop
- shampoo
- cream of tartar
- aspirin
- baking soda
- antacid tablet
- soap (bar)
- bleach
- fertilizer
- drain cleaner
- oven cleaner

Caution: Bleach, fertilizer, drain cleaner, and oven cleaner are corrosive. Avoid contact with skin and eyes.

Steps to Follow

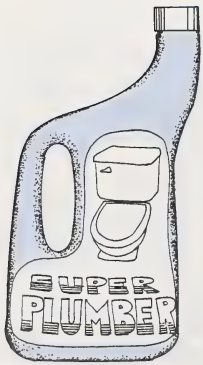
STEP A

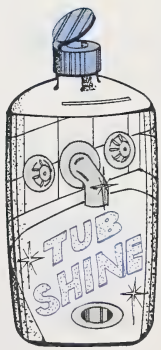
Use a spoon to get a small amount of one of the substances listed in the observations chart. If the substance is solid, dissolve it in a small amount of water before testing it. Dip the pH paper into the solution in the spoon. Remove the wet pH paper and use the colour scale provided with the pH paper to estimate the pH of the solution. Record your answers in the chart provided in the observations section.

Observations

STEP A

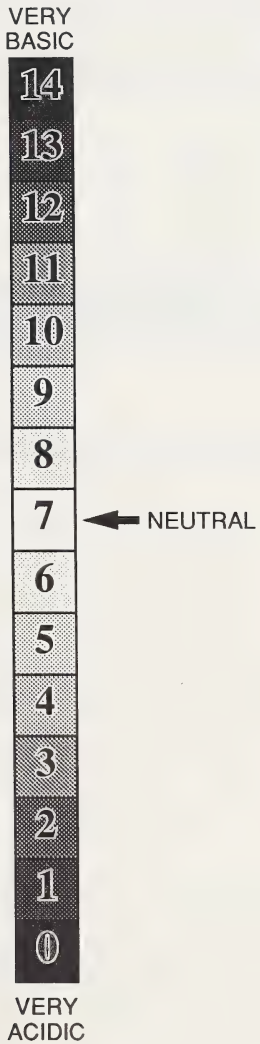
Substance	pH	Substance	pH
orange juice		baking soda	
pickle juice		antacid tablet	
vinegar		bar soap	
soda pop		bleach	
shampoo		fertilizer	
cream of tartar		drain cleaner	
aspirin		oven cleaner	





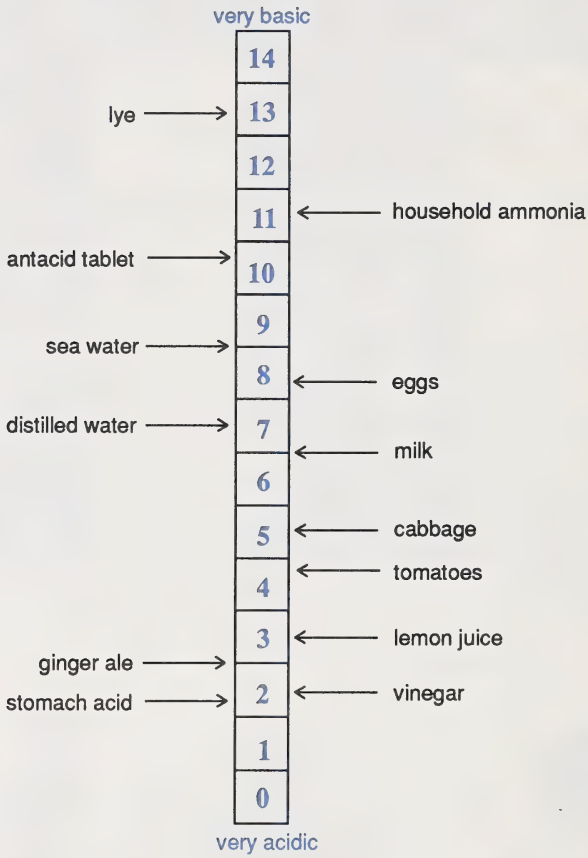
Conclusion

Rank the substances you tested by writing the name of the substance beside the pH of that substance.



By now you will have noticed that the pH scale ranges from 0 to 14, with 7 being neutral. The pH of acids ranges from 0 to 7, with 0 being the most acidic. The pH for bases ranges from 7 to 14, with 14 being the most basic.

The following diagram provides you with the pH of many common substances. You will have to assume that the concentrations of these substances are all the same. (The next investigation will make the term *concentration* clear).



1. What is the range of pH for acids?

_____

2. What is the range of pH for bases?

_____

It is important to understand that pH is a scale which goes up by a ratio of 10 to 1. For example, an acid of pH = 5 is ten times more acidic than an acid of pH = 6. Also, an acid of pH = 4 is 100 times more acidic than an acid of pH = 6.

3. How many times more acidic is an acid of pH = 1 than an acid of pH = 5?

_____

_____

4. How many times more basic is a substance of pH = 12 than a substance of pH = 9?

_____

_____

Check your answers by turning to the Appendix, Section 1: Activity 3.

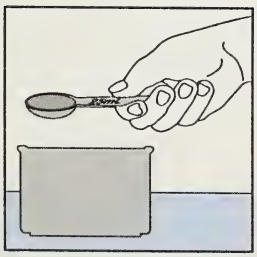
Investigation: Concentrated and Dilute Acids and Bases

Does the pH of a substance change when it is diluted with water?

Materials You Need

- pH indicator paper
- vinegar
- drain cleaner or oven cleaner
- measuring cup
- bowl

Steps to Follow



STEP A	OBSERVATION
Measure 25 mL of vinegar into a bowl. Determine the pH of the vinegar using a piece of pH indicator paper. You will call this pure vinegar *concentrated vinegar.*	5. What is the pH of the concentrated vinegar? _____ _____

STEP B

Add 250 mL of water to the vinegar in the bowl. Find the pH of this diluted vinegar solution.

OBSERVATION

6. What is the pH of the diluted vinegar solution? (25 mL vinegar + 250 mL water)

_____

_____

STEP C

Add another 250 mL of water to the vinegar solution in the bowl. Find the pH of this vinegar solution.

OBSERVATION

7. What is the pH of this diluted vinegar solution? (25 mL vinegar + 500 mL water)

_____

_____

STEP D

Add 500 mL of water to the vinegar solution. Find the pH of this vinegar solution.

OBSERVATION

8. What is the pH of this diluted vinegar solution? (25 mL vinegar + 1000 mL water)

_____

_____

STEP E

Pour the vinegar solution down the drain and wash the bowl and measuring cup. Repeat steps A to D using drain cleaner or oven cleaner. Record the pH of each solution.

OBSERVATION	
Solution	**pH**
25 mL cleaner	
25 mL cleaner + 250 mL water	
25 mL cleaner + 500 mL water	
25 mL cleaner + 1000 mL water	

Conclusion

The pH of a substance depends on how concentrated or diluted the substance is. In this investigation you tested vinegar and a cleaner. The vinegar solutions had a variety of pH values, as did the cleaner. Thus, it would not be correct to say that the pH of vinegar is 2 unless the concentration of vinegar is known. Be careful when using the terms *strong* or *weak* to refer to an acid or a base. The concentration of the solution is also very important.

corrosive - destroys human tissue

Strong, concentrated acids, such as battery acid, and strong, concentrated bases, such as liquid drain cleaner, are called corrosive. If human flesh comes in contact with a corrosive substance, a severe burn will occur. Watch for this symbol on products.

A household product with this symbol on its label is corrosive.

9. Apply what you have learned to describe the proper method of treating someone who has had an accident with a concentrated acid or base. Describe how to treat a skin burn and how to treat someone who has swallowed a corrosive substance.

Check your answers by turning to the Appendix, Section 1: Activity 3.

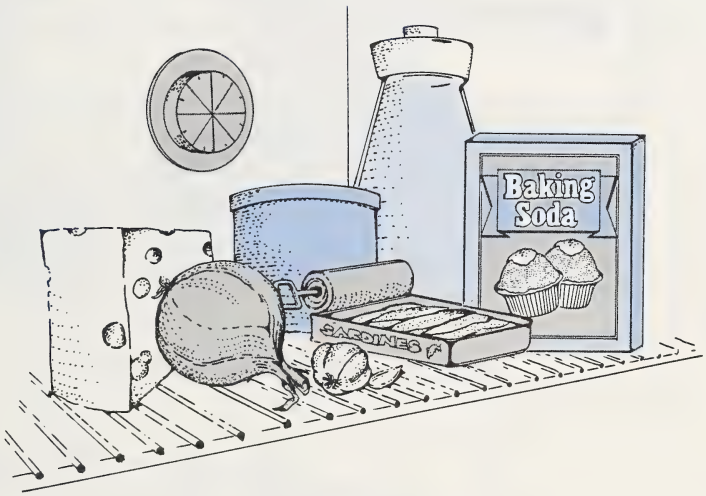
The pH of a liquid will tell you if the substance is an acid or a base and will also tell you how concentrated the substance is. Concentrated acids and bases are very dangerous. Do not handle corrosive fluids unless you know exactly what you are doing and have adequate protection. If you should get a corrosive substance on your skin, be sure to flush with plenty of cold water and then go to a doctor.

Activity 4: Mixing Acids and Bases

chemical reaction - involves the breaking of bonds that hold molecules together and the production of new molecules

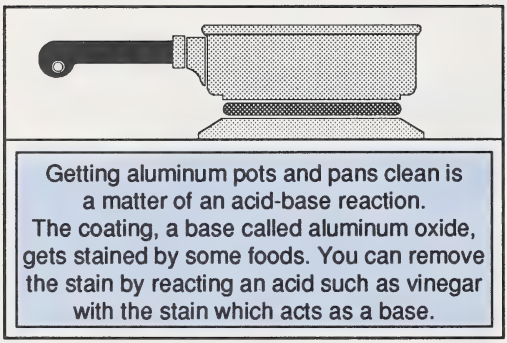
When you mix an acid and a base a **chemical reaction** occurs. Heat is produced, new compounds are formed, and the resulting solution is less acidic or less basic than the original solution. What happened? This is not an easy question to answer. For example, imagine that a small child is with you at a fireworks display. A person lights a small firecracker and it explodes with a bang. The small child asks you, "What happened?" Would you be able to explain the event in such a way that the child would understand? Or would you simply say, "Firecrackers explode with a bang when you light them." In a similar explanation it could be said that acids and bases react when they are mixed. The reaction is complex and can be hard to explain in more detail. It can be very simply said that acids react fastest with a base and that a base will react fastest with an acid. In other words, if you gave an acid the option of reacting with a variety of substances, the acid would react with the strongest base first. The reaction between an acid and a base is called a **neutralization reaction**.

neutralization reaction - a reaction between an acid and a base where both the acid and base are made neutral (pH = 7)

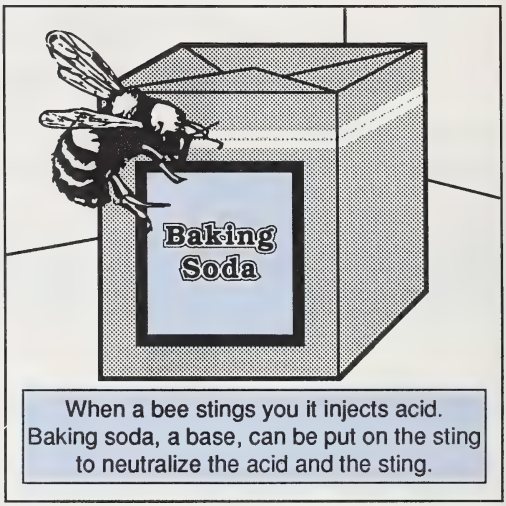


Many food odours are acidic. These acidic smells can be eliminated by neutralizing them with a base such as baking soda.

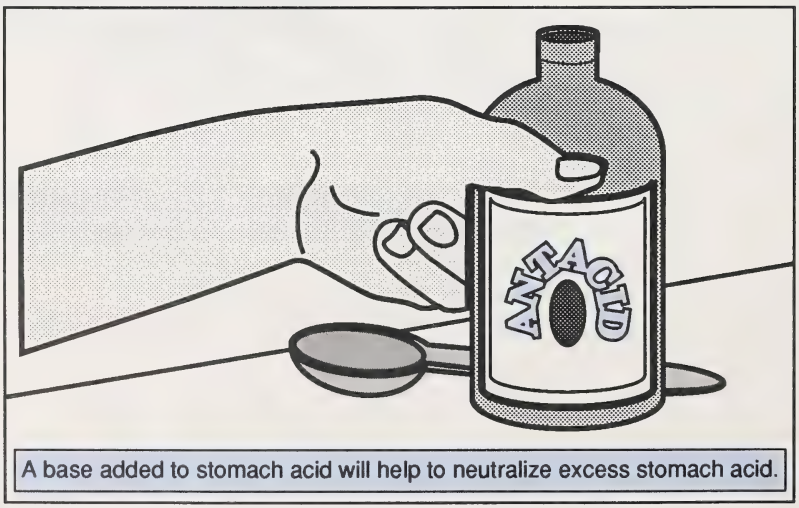
There are many acid-base reactions that are used in the home. Fluffy pastries are made by using an acid-base reaction to produce a gas (carbon dioxide) which makes gas pockets in the pastry. This is how breads and cakes are made to rise. Baking soda or baking powder is the base used to produce the gas. The acid may be cream of tartar or natural acids that are contained in the ingredients. Baking soda is used in your fridge to neutralize the acids that are part of the bad odours from food. You take an antacid to neutralize the excess stomach acid which gives you heartburn. Can you think of any other acid-base reactions that you may use in your everyday activities?



Getting aluminum pots and pans clean is a matter of an acid-base reaction. The coating, a base called aluminum oxide, gets stained by some foods. You can remove the stain by reacting an acid such as vinegar with the stain which acts as a base.



When a bee stings you it injects acid. Baking soda, a base, can be put on the sting to neutralize the acid and the sting.



A base added to stomach acid will help to neutralize excess stomach acid.

1. What two things are always produced when an acid reacts with a base?

_____

_____

2. What are the substances that react in a neutralization reaction?

_____

3. The first aid treatment often recommended for someone who swallows a corrosive acid or base is to drink milk and get medical help immediately. Why do you think milk, not water, is recommended?

_____

_____

_____

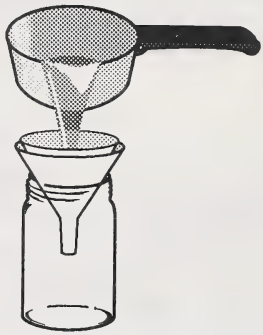
Investigation: Home Brew Indicators

Materials You Need

- pH indicator paper
- vinegar
- baking soda
- drain cleaner
- red cabbage (a few leaves)
- pot
- filter paper
- funnel

STEP A

Add about 200 mL of water to the pot. Add a few red cabbage leaves and boil the leaves for a few minutes or until you see that the water is well coloured. Remove the pot from the heat and allow the water to cool. Use the funnel and filter paper to filter the solution into a small jar. You have just created a home brew indicator.



STEP B

Pour a small amount of one of the substances on the list into a clean jar. Add a few drops of your home brew indicator. Record the colour. Test the pH using pH indicator paper and record the pH. Repeat this process for each of the substances on the list.

OBSERVATION

Solution	Colour	pH
vinegar		
baking soda		
drain cleaner		

There are many other fruits and vegetables which make good indicators. You might want to try plum skins, blueberries, or various vegetables, such as beets and carrots.

Conclusions

4. What is the pH range at which red cabbage juice indicator is useful?

_____

_____

5. Why or why would you not use natural juices to make commercial indicators?

_____

_____

_____

Check your answers by turning to the Appendix, Section 1: Activity 4.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

The following is a summary of what you have learned about acids and bases.

- Properties and Characteristics

  Acids

  – taste sour
  – turn litmus paper red
  – neutralize bases
  – react with metals

  Bases

  – taste bitter
  – turn litmus paper blue
  – neutralize acids
  – react with oils

- pH
  - measures acid and base concentrations
  - the pH of a base is greater than 7
  - the pH of an acid is less than 7
  - the pH of a neutral solution is equal to 7
  - pH indicator paper can be used to find the pH of a solution

- Acid-Base Reactions
  - occur often in the home
  - acid-base reactions are called neutralization reactions
  - may be dangerous or beneficial, depending on the substances that react
  - cleaning products are often bases

To review what was discussed in Section 1, decide whether the following statements are true or false. Place a **T** by those statements which are true and an **F** by those statements that are false. Rewrite the false statements to make them true.

1. _____ Acids dissolve fats and grease.
2. _____ Bases turn red litmus blue.
3. _____ Acids taste bitter.
4. _____ Lemon juice turns litmus paper red.
5. _____ An acid can neutralize a base.
6. _____ A substance with a pH of 2.5 is a concentrated base.
7. _____ Acids react with metals.
8. _____ Battery acid is a weak acid.
9. _____ All acid-base reactions are useful.
10. _____ The pH of acids is greater than 7.
11. _____ A neutral solution has a pH equal to 7.
12. _____ Corrosive burns should be flushed with cold water immediately.
13. _____ Many household cleaners are basic.

14. _____ Indicators cause acids and bases to change colour.

15. _____ Adding water to an acid or base changes the pH of the acid or base.

Check your answers by turning to the Appendix, Section 1: Extra Help.

Enrichment

Antacids work to neutralize stomach acid. How effective are different brands of antacids? You can test this in the following investigation.

Investigation: Antacid Effectiveness

Materials You Need

- phenolphthalein indicator
- 25 mL vinegar
- antacid tablets (two different brands)
- measuring cup
- glass or jar
- large spoon (tablespoon)
- paper (one sheet or newspaper)
- one Robertson screw
- eyedropper

Steps to Follow

STEP A

Use a timing device (watch or clock) to compare the dissolving speeds of the antacids. Drop an antacid tablet into a glass of water and time how long it takes for the tablet to dissolve completely.

OBSERVATION

Antacid	Dissolving Time
Tablet A	
Tablet B	

1. Which antacid would act the fastest? Why?

_____

_____

STEP B

Place a tablet of Antacid A in a folded piece of paper and crush it with the large spoon. Fill (to level) the hole in the top of the screw with some of the powdered antacid tablet. Add this to 50 mL of water in a glass. Swirl the water until all of the powder is dissolved. Add 3 drops of phenolphthalein indicator.

Use the hole in the end of a Robertson screw as a very small measuring cup.

OBSERVATION

2. What colour was the solution before you added the phenolphthalein indicator?

_____

3. What colour did the solution turn when you added the phenolphthalein solution?

_____

STEP C

Use the eyedropper to slowly add vinegar to the solution from step B. Swirl the solution after each drop of vinegar is added. Count the number of drops required to make the solution turn completely clear. When the indicator turns clear, the antacid has completely neutralized the acid in the vinegar. Record your observations. Repeat steps B and C for the second brand of antacid. Make sure you wash the glass and screw between trials.

OBSERVATION

Antacid	Drops of Acid
Tablet A	
Tablet B	

Conclusions

4. Phenolphthalein indicator changes colour in acids and bases. What colour is phenolphthalein in

   a. an acid?

   _____

   b. a base?

   _____

5. On the basis of both tests, which brand of antacid tablet would you deem most effective? Explain why you answered as you did.

   _____

   _____

   _____

   _____

6. Explain why one antacid tablet might neutralize 10 mL of one acid but only 1 mL of another acid.

_____

_____

_____

_____

7. Are your results from this experiment valid? What should you do to make your results more convincing to someone else?

_____

_____

_____

_____

Check your answers by turning to the Appendix, Section 1: Enrichment.

Conclusion

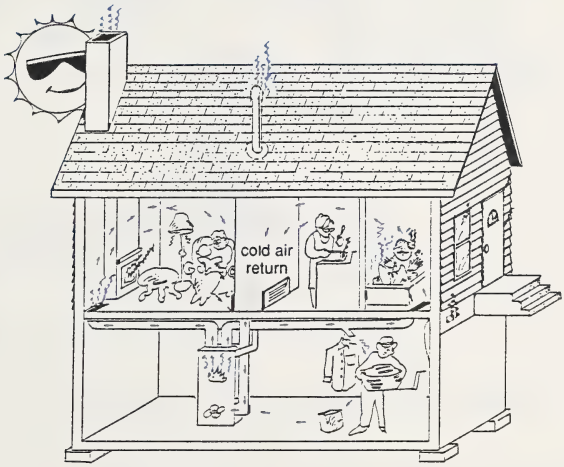
In this section you have learned about the properties of acids and bases and how to identify them by using taste, the feel of the substance, and pH values. You should now be able to identify acids and bases in your home. The reactions of acids and bases are also of importance because some are useful in the home. Remember that acid-base reactions are potentially dangerous and care should always be taken when using acids and bases.

Assignment Booklet

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 1.

2 Heating and Cooling



It's a cold, frosty morning when you crawl out of bed. The house is a cool 18° C. How do you warm the place up? Turn up the thermostat! Do you know where the heat comes from and how it is produced?

If you want fried eggs and toast for breakfast, what do you do? Fry the eggs in a hot frying pan and toast the bread in the toaster.

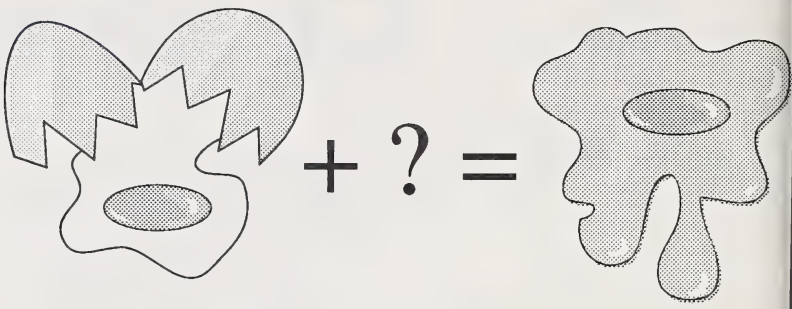
When you have a shower you must first get the water to a temperature that you like. You do this by getting the right mixture of hot and cold water.

On a hot summer day you probably enjoy a cold drink. Ice cubes in your drink will make it nice and cold. Where did the ice cubes come from on such a hot day? "From the freezer" is not a very satisfying answer. How does the freezer get cold enough to freeze water on a hot day?

In Section 2 you will learn that some reactions require heat, while other reactions release heat. You will also consider the ways that heat is transferred from one object to another. You may be surprised to discover how many household products are designed to use heat.

Activity 1: You Gain Some, You Lose Some

When you wish to enhance the flavour of your fried egg you add salt and pepper. What did you add to the raw egg to turn it into a fried egg?



Did you guess that you added heat? If you did, you are absolutely correct! Households use heat so often in daily activities that people rarely think about it until they get burned, have a fire, or lose the heat source.

1. What are some household processes that require heat?

_____

_____

_____

_____

Where does the heat for these processes come from? You might think that heat comes from fire, but actually natural gas and propane are the most common fuels that are used for heating purposes. Some people also use wood, coal, or other fuels to produce heat.

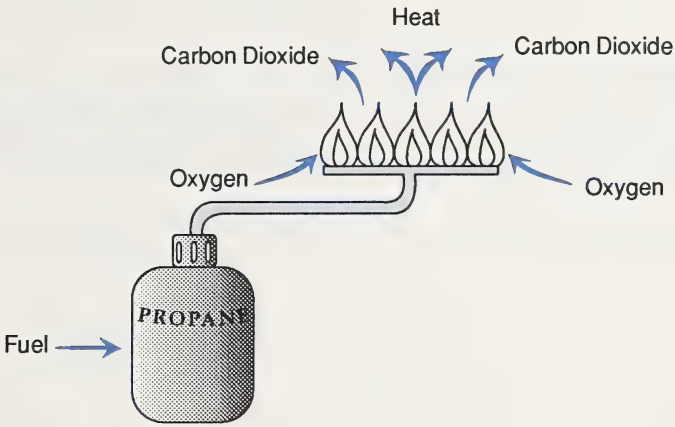
You might have said that heat comes from electricity. What energy source is used to generate electricity? The most common energy source used to produce household electricity in Alberta is coal. Some other energy sources are natural gas, nuclear fuel, solar radiation (sun), geothermal (hot water from deep in the earth), wind, and water (hydro).

Wind and water are used to produce electricity? Yes, wind and running water are used to turn turbines which, in turn, run the generators that produce electricity. The sun's heat energy is ultimately converted into wind and water energy. Thus, even though you do not normally call electricity a fuel, you can see that electricity must come from a fuel source of some kind.

combustion - a rapid chemical reaction between a fuel and oxygen. Heat and waste gases are produced.

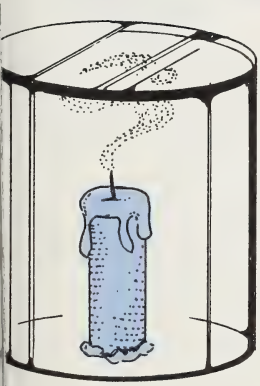
water vapour - water that is in the gaseous state. Water vapour is also called steam.

When a fuel reacts (burns) with oxygen it is called a **combustion** reaction. Most of the combustion reactions in your household use organic fuels such as natural gas, propane, and gasoline. The main products of the combustion of organic fuels are carbon dioxide and **water vapour**. Some other products of combustion are carbon monoxide, nitrogen oxides, and sulfur oxides. These are found in much smaller amounts than water vapour and carbon dioxide.



You can write the main parts of the combustion reaction in a word equation.

Fuel + Oxygen → Carbon Dioxide + Water Vapour

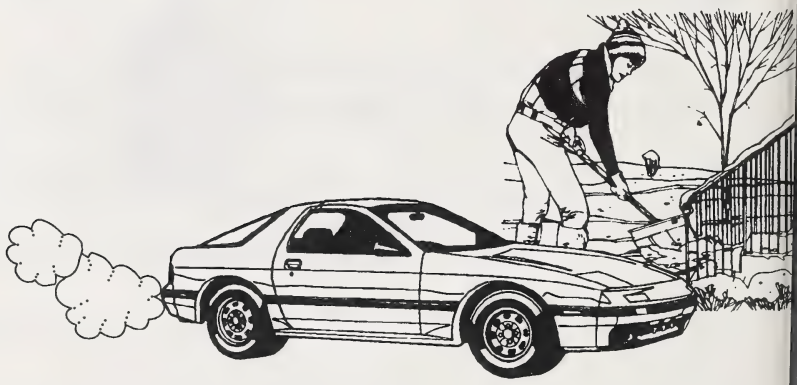


2. Use the preceding word equation to answer the following questions.

   a. Why does a candle go out shortly after it is covered with a glass?

b. Why is it dangerous to burn campfires or have any kind of fire outside on windy days?

c. Why do you see a white cloud of exhaust behind cars in the winter but not in the summer? What is the product of combustion in the exhaust which is responsible for the white cloud?



3. The organic fuels which are commonly used today are refined from crude oil. What fuels did people use before oil-based fuels were discovered?

_____

_____

_____

Have people always had a stove to cook their food? Have people always had a furnace to heat their homes? People used to use open fires to heat their shelter and cook their food. Today there are a great variety of appliances which use the heat from combustion to make your life more comfortable.

4. How many appliances in your household use controlled combustion? List as many as you can.

_____

_____

_____

_____

Investigation: Heat Reactions

In this investigation you will look more closely at the combustion reactions that occur in your home.

Materials You Need

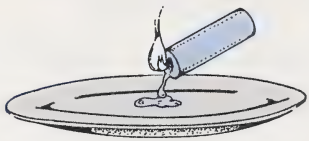
- short candle (a birthday candle will work)
- two tall jars or beakers
- ice cubes
- masking tape
- glass bowl or pie plate
- matches

Caution: You will be using a burning candle. Be sure to tie back any long hair and tuck in all loose clothing. Do not use an open flame near any combustible materials.

Steps to Follow

STEP A

Secure the candle to the bottom of the bowl or pie plate. You can do this by lighting the candle and letting four or five drops of wax drip into the centre of the bowl or pan. Stick the bottom of the candle into the hot wax drippings and hold the candle upright until the wax cools. This will secure the candle to the bottom of the bowl or plate.



STEP B

Watch the burning candle for a while. Write down any interesting things that you notice. Blow out the candle and answer the questions 5 and 6.

OBSERVATION

5. How do you know that this is a combustion reaction?

_____

_____

6. Where else in this investigation has there already been a combustion reaction?

_____

_____

STEP C

Add a few ice cubes to a glass jar. Let the jar cool for a few minutes. When the jar is cold, relight the candle and hold the jar over the flame.

OBSERVATION

7. What has formed on the outside of the jar?

_____

8. Where did it come from?

_____

_____

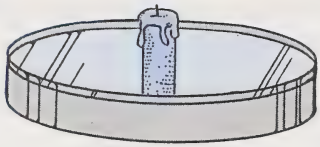
9. Feel the bottom of the beaker. What is another product of combustion?

_____

Water vapour, carbon dioxide, and heat are the products of combustion. The reason that you see water droplets on the outside of the cold jar is that water vapour condenses from a gas to a liquid when it comes into contact with the cold surface of the jar. Did you see the water vapour coming from the burning candle in step B? Of course not – the cold jar was needed to show you that water is a product of combustion.

STEP D

Add water (about 3 cm) to the plate or bowl.

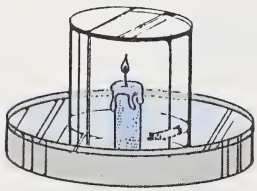


STEP E

Place the empty jar over the candle. Mark the level of the water on the jar with a piece of masking tape.

STEP F

Remove the jar and light the candle. Replace the jar over the burning candle and observe what happens.



OBSERVATION

10. Why didn't the flame go out as soon as you covered the candle with the jar?

Why did the water level in the jar go up? Give this some thought. What are the products of combustion? Carbon dioxide, water vapour, and heat. Remember what you found on the sides and bottom of the cold jar when it was placed over the candle? Right, it was water. The same reasoning can be used to answer this question. The water vapour (from the candle) condensed into liquid water and caused the water level to rise. Also, less carbon dioxide gas (by volume) was produced than oxygen was used, so the volume of gases in the jar went down. The water then rose up to fill the gap. Actually, the complete answer to this question is even more complicated, but the explanation here will account for most of the increase in water level. The heat that the candle produced was absorbed by the water, surrounding air, and the jar.

Conclusions

11. What two things are required for combustion to occur?

    _____

12. What three things are produced when combustion occurs?

    _____

    _____

    _____

13. Write an equation for the combustion reaction using the main reactants and products that you mentioned in the above questions.

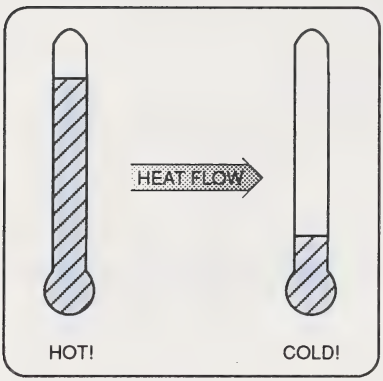
    _____

Do you ever wonder why it is so hard to learn some things and so easy to learn other things? Sometimes what you already know makes it easier or harder to learn new things. Sometimes you have to unlearn some ideas so that you can learn new ones. Study the following examples.

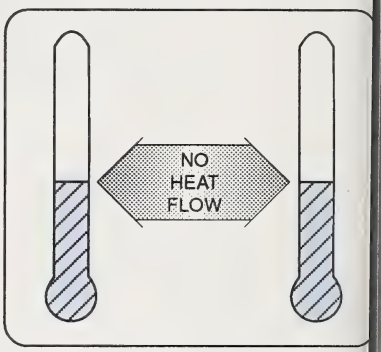
What happens when you add ice cubes to your iced tea on a hot day? The ice cools the drink. What happens when you plug the kettle or coffee pot into the electrical outlet? The kettle heats the water. What happens when your hands or feet get cold on a wintery day? The cold air freezes your hands. There are probably countless other examples of heating and cooling that seem to contradict one another.

A large green Martian was sent to Earth to investigate humankind. The Martian first met a little boy standing outside, shivering in the cold. The boy was blowing into his cupped hands. The Martian asked, "What are you doing?" The little boy replied, "I'm blowing on my hands to warm them up." They both went inside for some hot chocolate. The little boy started blowing on his hot drink. "What are you doing now?" asked the Martian. "I'm blowing on my hot chocolate to cool it off," replied the little boy. The Martian reported to home base that Earthlings are strange!

There are two main ideas to keep in mind when dealing with heat transfer.



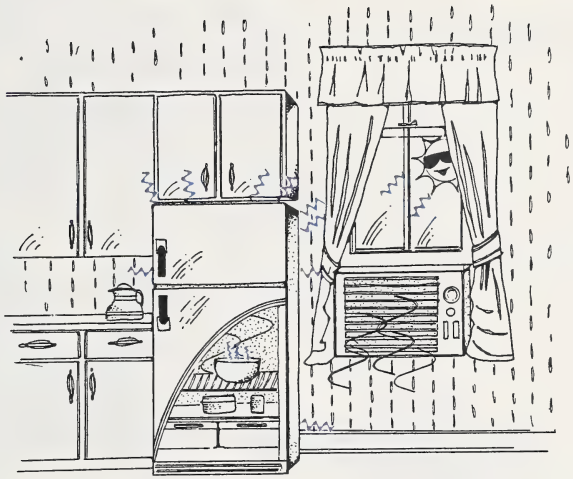
Heat is always transferred from the hot object to the cold object.



When both objects are the same temperature, there is no heat flow between them.

These two ideas hold true regardless of the temperatures.

Now use your new knowledge to explain the everyday experiences that you just looked at. When you put ice into your drink the heat is actually transferred from the warm drink to the cold ice cubes, in effect cooling the drink. When you use the kettle the hot element transfers the heat to the cool water, causing the water to get hot. On a cold winter day your hands transfer heat to the cold air. This has the effect of cooling your hands. When you blow on your hands the heat from your breath is transferred to your hands, in effect warming them up. When you blow on your hot chocolate it transfers the heat from the hot chocolate to the fast-moving air above it, in effect cooling the hot chocolate.



14. Use the principles of heat transfer to explain how hot pudding cools in the fridge, how the fridge then heats up your kitchen, and how the air conditioner then cools off the kitchen!

Did you know that electric motors give off heat when they work? Did you know that your refrigerator and air conditioner use electric motors to do their work? Well, they do! Therefore, in order to cool down your pudding, heat is generated by the refrigerator motor and even more heat is generated by the air conditioner. Do you know where the electricity that runs these electric motors comes from? The electricity is probably generated by a coal-fired power plant which produces waste heat and gases. Did you think of where all of this waste heat and gas ends up? It all ends up in the environment and the atmosphere. Thus, every time you use electricity you are indirectly producing waste heat.

Since you need lots of heat for your home in the winter, can you think of any ways to capture the waste heat that is produced in the summer and save it until it can be used in the winter?

15. Some people will tell you that ice cubes transfer their cold to the iced tea in their glass. Use your knowledge of heat transfer to explain what is really happening.

Check your answers by turning to the Appendix, Section 2: Activity 1.

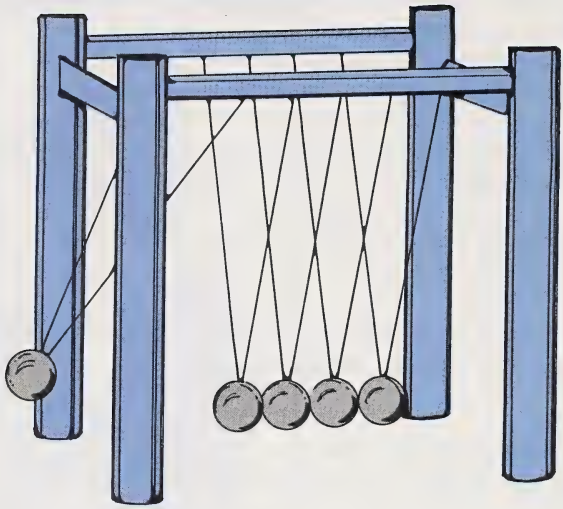
So far you have learned that heat can be transferred. In the next three activities you will learn about three different ways that heat is transferred.

Activity 2: Now You're Cooking – Conduction

Have you ever grabbed the gravy ladle or the soup ladle and burned yourself? Why does the ladle get hot? You probably know now that the hot gravy or soup transfers its heat to the ladle. Look at the sequence of events which causes the ladle to get hot. The hot element of the stove heats the pot, which in turn heats the soup, which in turn heats the spoon, which in turn burns your hand. What do all of these things have in common? They are all in contact with each other. Can you get burned by a hot spoon if you are not touching it? Of course not. This form of heat transfer is given a special name – **conduction**. The substance which conducts heat is called a **conductor**. The molecules of the conductor transfer heat by colliding with neighbouring molecules.

conduction – the transfer of heat through a substance or from one substance to another when the substances are touching

conductor - substance which allows heat to be transferred



Have you ever seen one of these devices? When the swinging ball comes in contact with the closest hanging ball, its energy is transferred through each of the other hanging balls. The ball on the opposite end will then swing out with most of the original energy. Heat is transferred by the molecules of a substance in much the same way. The molecules in a hot stove element bump and hit the molecules in the pot, causing the pot to get hot. The molecules in the hot pot then bump and hit the molecules in the gravy or soup, making it hot. In turn, the molecules in the hot gravy or soup bump and hit the molecules in the ladle, making the ladle hot. The molecules in the hot ladle bump and hit the molecules in your hand, making your skin hot. The nerves in your hand send a message to your brain which responds by making you jump, let go of the ladle, and feel the pain caused by the burn. All of these substances transfer heat by conduction.

1. List at least five appliances in your home that transfer heat by conduction.

_____

_____

_____

Investigation: Testing Conductors

In this investigation you will look at different types of solids and investigate their ability to conduct heat.

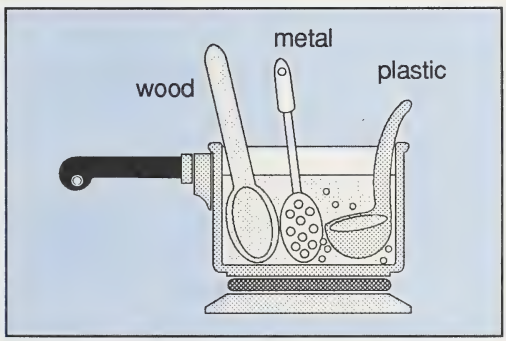
Materials You Need

- metal spoon
- wooden spoon
- plastic spoon
- pot
- stove or hot plate
- clock or watch with a second hand

Steps to Follow

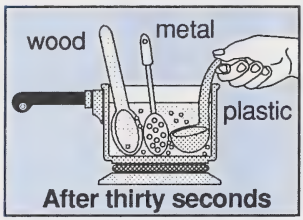
STEP A

Fill the pot 3/4 full of water and place it on the stove or hot plate. Turn the heat to high and wait for the water to boil. When the water is boiling, turn the heat down to simmer. Place all three spoons into the water for 30 seconds. (Use your clock or watch to measure the time.)



STEP B

After 30 seconds, touch each spoon with your finger. Be careful not to burn yourself – touch each spoon quickly at first. If it feels cool, you can touch it longer to get a better idea of its relative temperature.



After thirty seconds

OBSERVATION

Label the spoons as to which one felt hottest, coldest, and in between.

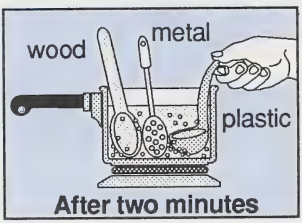
wood _____

metal _____

plastic _____

STEP C

Continue heating the water and spoons for another 2 minutes, then turn the heat off. Touch each spoon again and record your observations.



After two minutes

OBSERVATION

Label the spoons as to which felt hottest, coldest, and in between.

wood _____

metal _____

plastic _____

Conclusions

2. Which material was the best conductor of heat?

_____

3. Which material was the poorest conductor of heat?

_____

4. What explanations can you come up with to explain why metal is a good conductor of heat, as compared to wood or plastic?

_____

_____

_____

_____

5. List five household items which are good conductors.

_____

_____

6. List five household items which are poor conductors.

_____

_____

7. If you search through the cupboards and drawers of your home, you will probably find many examples of good conductors that are used for cooking. In many cases the good conductor has a handle or an end made of a poor conductor. A good example is a pot used for cooking. Why do these good conductors have a poor conductor attached?

_____

_____

_____

insulator - a substance which is a poor conductor of heat

You have discovered that metal conducts heat better than wood or plastic. All metals are good conductors of heat. Substances which are poor conductors of heat are often called **insulators**.

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Air is an excellent insulator. There are many examples of using air as an insulator. Your clothing provides one such example. Sweaters, down-filled parkas, and felt-lined boots all use the insulating properties of air. Natural materials such as wool, hair, or feathers trap many small pockets of air. The trapped air is the reason why clothing made of these materials will keep you warm on cold days. Silk and nylon have few air pockets trapped within them. These materials are better conductors of heat and make good summer clothing. Air is also used as an insulator in your home. Modern windows have two or even three panes of glass with air trapped between them. Fiberglass insulation traps large amounts of air between its fibres. Polystyrene foam has large numbers of air bubbles trapped within the plastic. Are there any other insulators in your home which use trapped air?

Investigation: Testing Insulators

In this investigation you will test some common household substances for their insulation qualities.

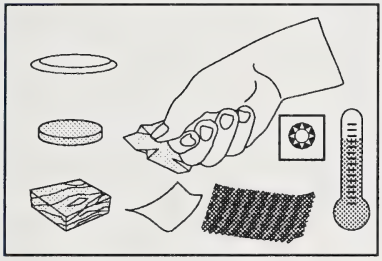
Materials You Need

- coin (quarter, dime, nickel, or penny)
- styrofoam cup or plate
- aluminum foil
- wooden block
- paper
- wool

Steps to Follow

STEP A

Place the materials on the counter and leave them for a few minutes. Touch each with a different finger for about 5 seconds. Record each as being warm or cold.

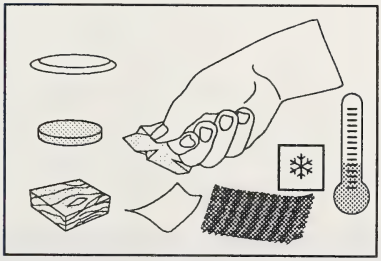


OBSERVATION

Substance	Feeling
coin	
polystyrene foam	
aluminum	
wood	
paper	
wool	

STEP B

Place all of the material into the freezer compartment of your refrigerator (or into your deep freeze). Wait 5 minutes. Place the materials back on the counter and touch each with a different finger for about 5 seconds. Record your feeling for each.



OBSERVATION

Substance	Feeling
coin	
polystyrene foam	
aluminum	
wood	
paper	
wool	

Conclusions

8. Which of the materials felt warmest?

_____

9. Which of the materials felt coldest?

_____

Think about the results. When you touch a substance that is a good conductor, the substance will feel cold because the heat from your finger is quickly taken away by the conductor. When you touch a substance which is a poor conductor (an insulator), the substance will feel warm after only a short while because the heat from your finger is prevented from escaping. Insulators are used to keep things hot or cold. Do insulators have the ability to cool things down or warm them up? No, they just slow down the loss or gain of heat.

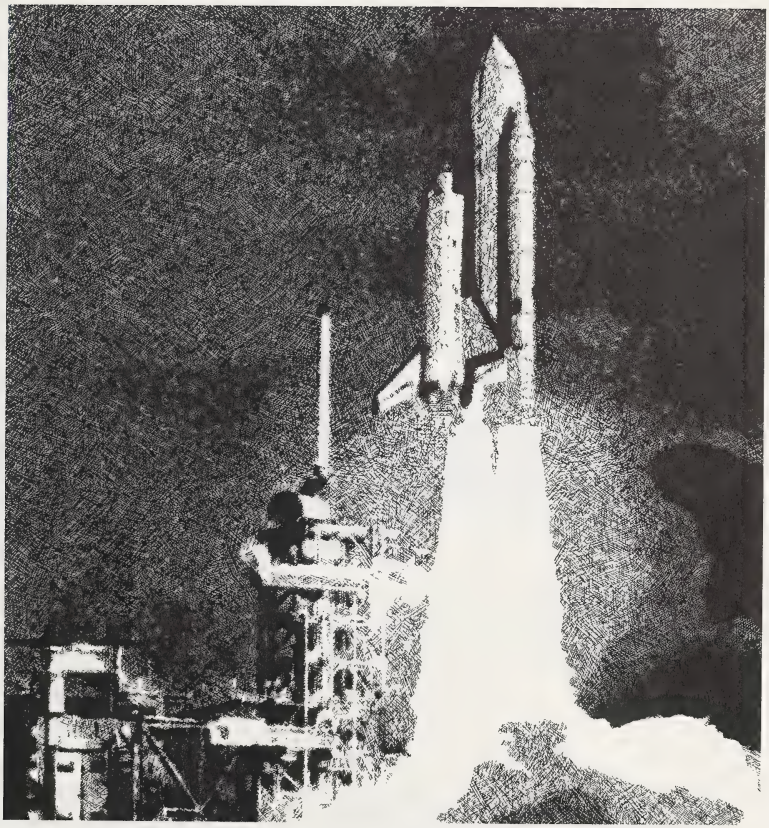
In order to stop the heat from moving beyond your shirt when you iron it, the ironing board cover (made from natural fibres like cotton and wool) was designed to be a good insulator. Have you ever ironed something and then touched the surface of the cover? Once again, it is important to notice that insulators will still conduct some heat and must be used with care.

10. Heat transfer sometimes happens very quickly. List some insulators that are used in your household to prevent burns to yourself or kitchen counters.

_____

_____

_____



11. The space shuttle requires a special insulator in order to travel into space and return safely to Earth. Find some information about the insulator which is used on the space shuttle and write a brief paragraph. Encyclopedias and flight or space technology texts are good sources of information.

_____

_____

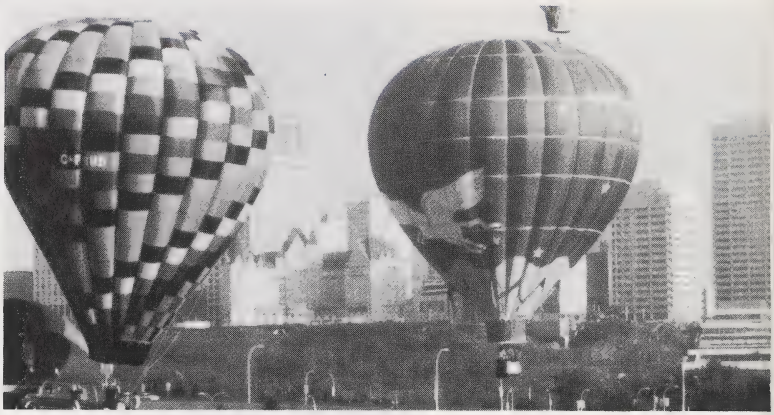
_____

_____

_____

Check your answers by turning to the Appendix, Section 2: Activity 2.

Activity 3: Warming Up to Household Science – Convection



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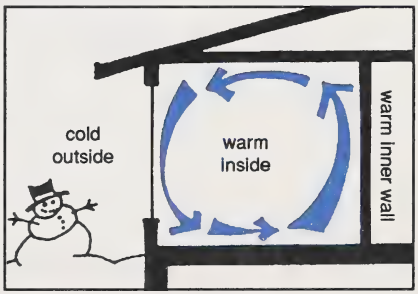
Do you ever wonder how hot air balloons and submarines work? They both work by using the principles of density. The hot air balloon is made to rise by heating the air that is trapped inside it. The balloon gets larger and will rise up into the air when it weighs less than the air that it displaces. In order to make the balloon come down, the hot air is released from the balloon until the balloon weighs more than the air that it displaces. Submarines work in much the same way, but use compressed air and water to change their density so that they can go up and down in the water as required.

convection - the transfer of heat from one place to another by a moving gas or liquid

Heat is also transferred in liquids and gases by **convection**.

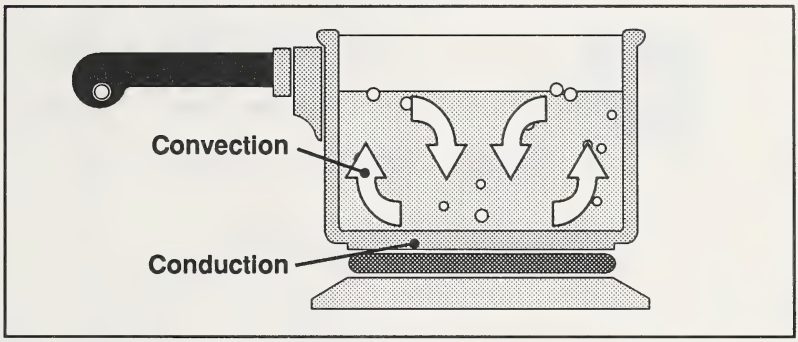


fluids - gases and liquids

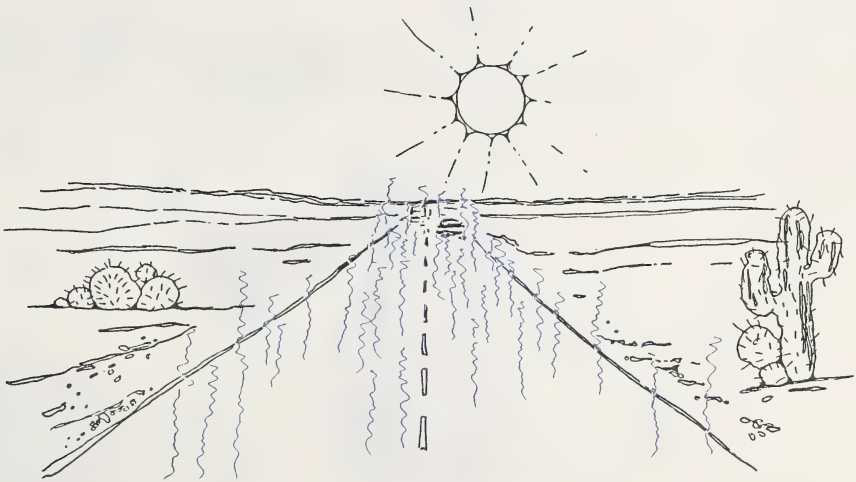
convection currents - movement of heated fluids where hot parts rise and cooler parts sink to take their place

Hot air rises. Hot liquids also rise. When liquids and gases are heated, they become lighter than the cooler liquids and gases around them. Because they are lighter, they rise above the heavier **fluids** which quickly rush down to fill the empty space left by the lighter fluids. This rising of lighter fluids and falling of heavier fluids creates **convection currents**. These convection currents are the reason why the water in a pot is not hot only at the bottom.

Why does the water in a pot of water get hot from top to bottom without stirring? The bottom of the pot is heated by the element. The pot then heats the water. These two heat transfers occur by conduction. The water transfers the heat evenly by convection. That is, the hot water rises and colder water sinks to take its place.



Sometimes winds are caused by convection currents, especially on a hot day when the ground is hotter than the air. Have you ever seen heat waves above a highway or above a black field? Heat waves are examples of visible convection currents in a fluid.



Most of the heat transfer within fluids occurs by convection. That is why some insulators use air as their main insulating material. The air gets trapped in small air pockets between the layers of the insulator. Circulation of air is needed in order to set up convection currents. Therefore, the dead air in the air pockets cannot transfer heat by convection.

Investigation: Convection Currents

In this investigation you will make convection currents that you can observe.

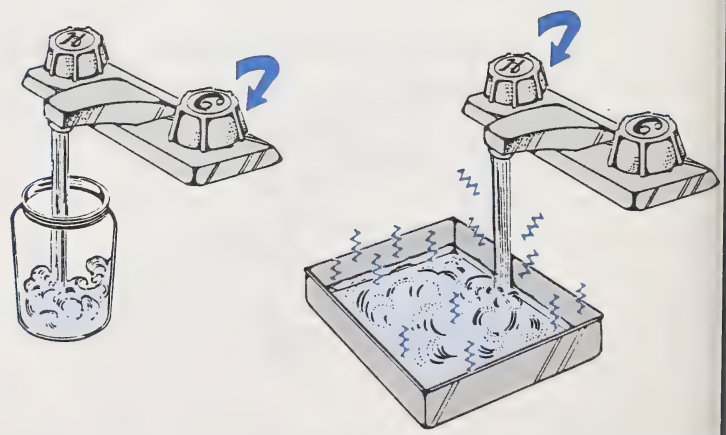
Materials You Need

- drinking straw
- food colouring
- hot and cold tap water
- 1 L jar
- cake pan with sides at least 5 cm high

Steps to Follow

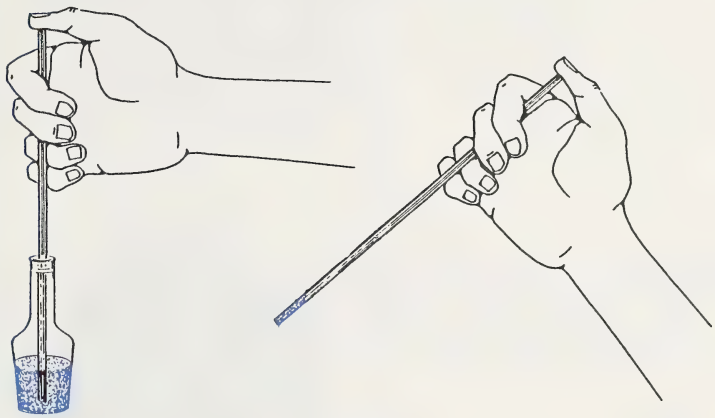
STEP A

Fill the jar with the coldest tap water you can get. Then run the hot water until you get the hottest water possible. Add about 2 or 3 cm of hot water to the cake pan.



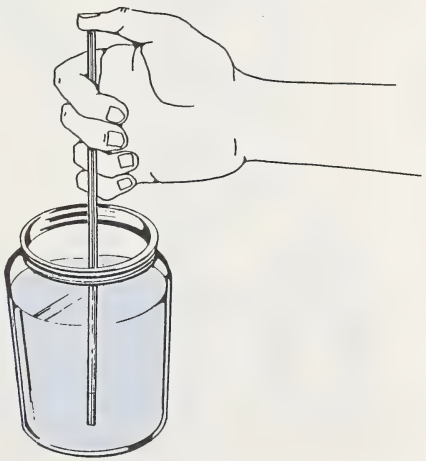
STEP B

Place the drinking straw into the food colouring container. Press your thumb against the end of the straw and remove the straw from the container. Wipe the end of the straw to prevent dripping.



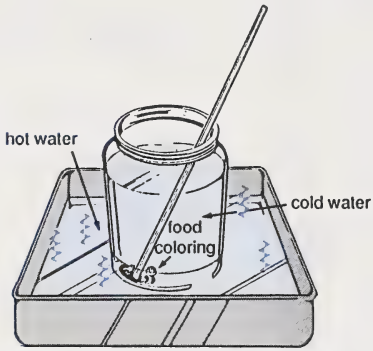
STEP C

Insert the straw into the bottom of the jar of cold water, making sure to keep your thumb over the end of the straw.



STEP D

Remove your thumb from the end of the straw to release the food colouring into the water. (You may have to gently blow the food colouring out of the straw.) Leave the straw in the jar of water. Place the jar in the pan of hot water. Record your observations for the next 5 minutes.



OBSERVATION

1. Draw a picture of the heat flow you observed in the jar.

Conclusions

2. Explain how you could show the convection currents in air to someone who does not believe that they exist.

_____

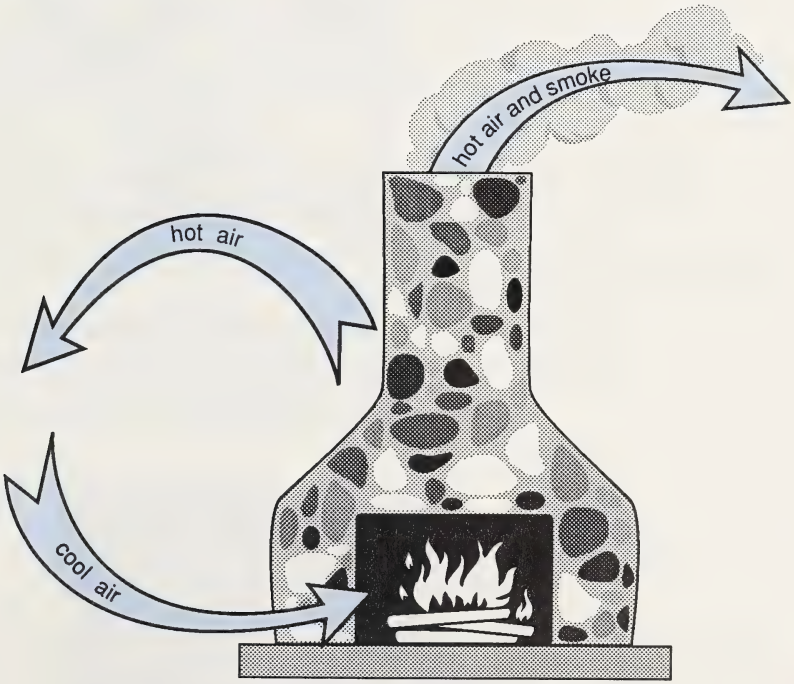
_____

_____

_____

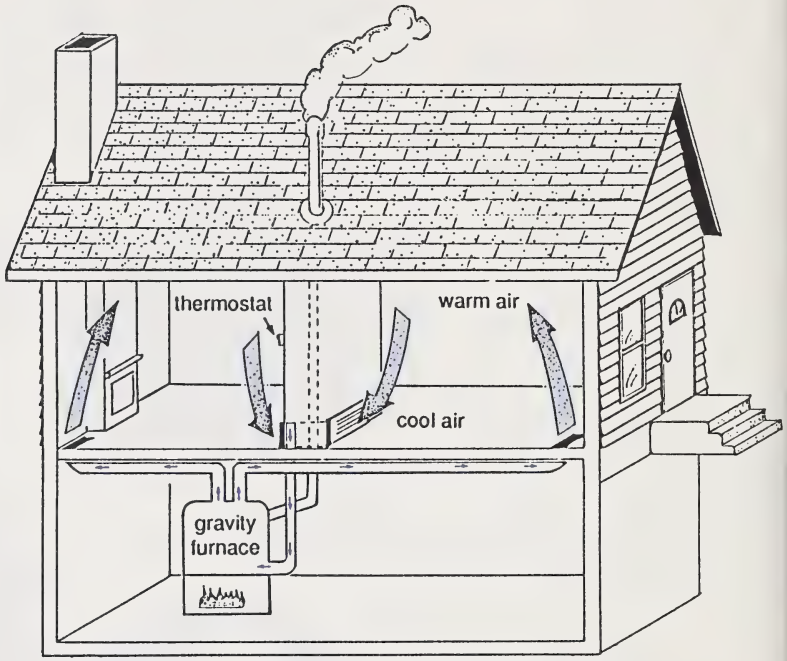
_____

As humans began to build more permanent homes, the need for heating and cooking with less smoke led to the invention of the chimney. The fire at the bottom of the chimney heats the air. The hot air rises, carrying the smoke up with it. Cool air is drawn into the bottom of the chimney to replace the hot air that has risen.

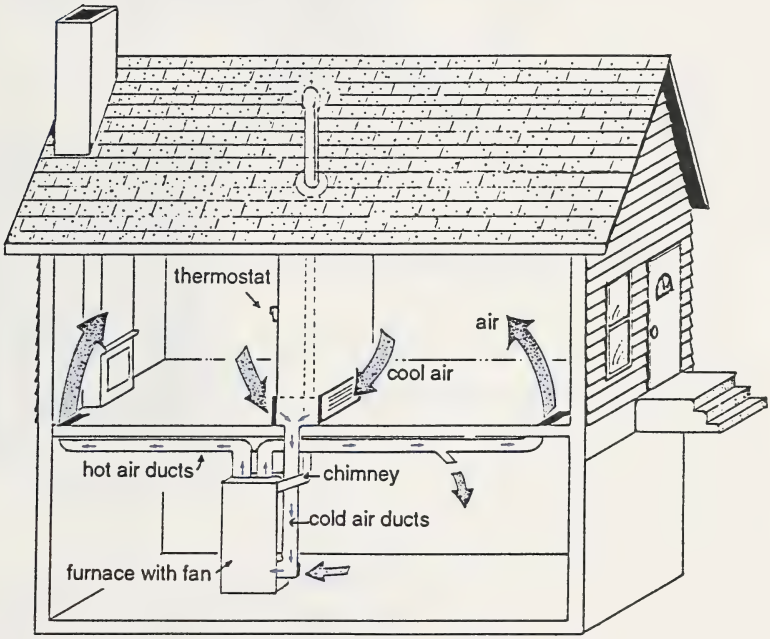


The home is also heated by convection.

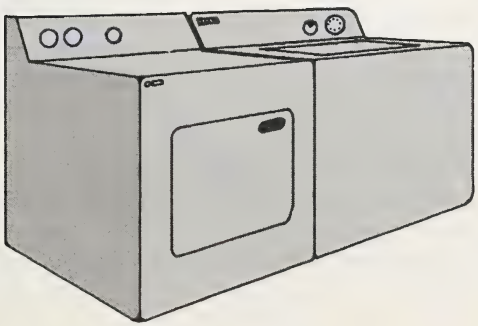
As technology improved, furnaces were built to heat homes using convection. They were called *gravity furnaces*. The cool, more dense air is drawn into the ducts in the centre of the house and is taken down into the furnace. The air is then heated and rises up to travel through the ducts to the outer edges of the house, where it is released. Follow the path of the air in the following diagram to see the convection currents.



Today's modern heating systems use *forced convection*. The furnace and ducts can be located anywhere in the house, but are usually installed in the basement for easier service and repair. An electric motor turns the fan that blows (or forces) heated air through the ducts.



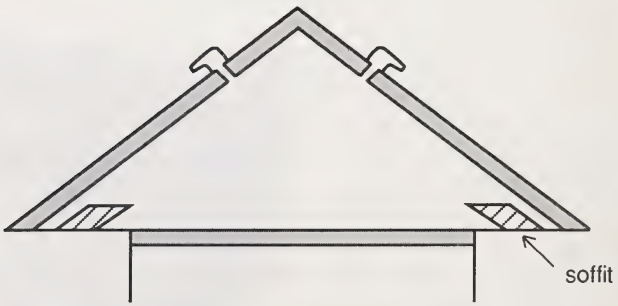
3. List as many devices (or parts of devices) as you can which use convection as a means of heating.



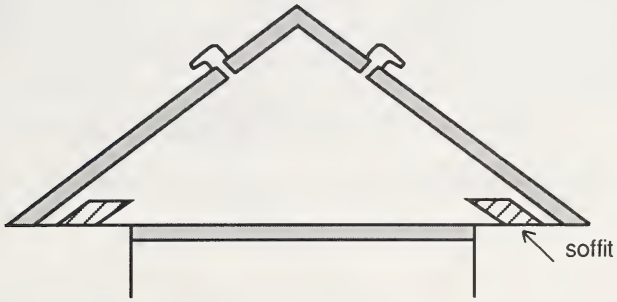
Convection currents are also used to cool things. Old refrigerators use convection to remove the heat from food. Look at the following diagram of the fridge.

The cooling coils are found in the freezer compartment. Why do you think the freezer is at the top of the fridge and not at the bottom? Cold air sinks to the bottom of the fridge and warm air rises to the top. In order to keep the entire fridge cold, it is only necessary to have cooling coils at the top. Convection takes care of the rest. This is certainly more efficient and inexpensive than having cooling coils all around the fridge! Do modern refrigerators have the freezer at the top? What about refrigerators which do not have a freezer compartment? Do they have a fan to circulate air?

Now look at the attics in houses! Do you see any evidence of convection being used to circulate air in the attic? Look carefully. Why are there holes in the soffits and vents on the roof? Think about convection.



4. Draw the convection currents which would be set up in the attic.



5. Explain why convection can occur in liquids and gases but not in solids.

Check your answers by turning to the Appendix, Section 2: Activity 3.

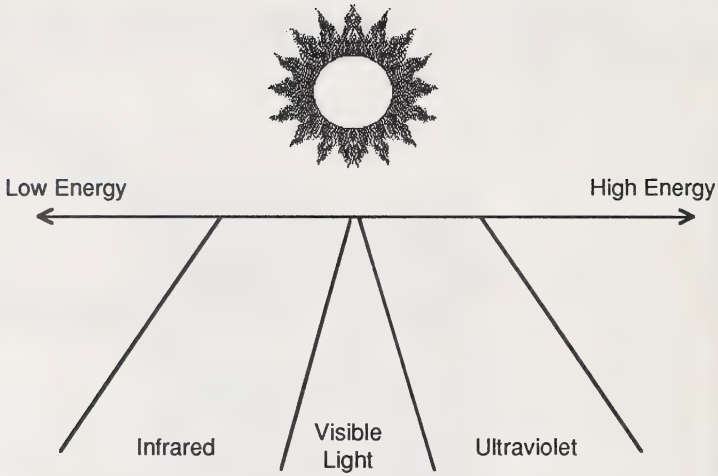
Activity 4: Catching the Rays – Radiation

So far you have studied heat transfer by conduction and convection. Can you use the principles of conduction or convection to explain how the heat from the sun gets to the earth? There are no solids, liquids, or gases between the earth and the sun, only empty space. There must be another way of transferring heat from one place to another through a **vacuum**.

acuum - space in which there is o matter

hoton - packets of lectromagnetic energy

How does the energy from the sun travel through space? All energy from the sun travels in wave-packets called **photons**. Photons can travel through empty space. Your eyes are only sensitive to photons within a small range of energy. The following diagram shows how little of the sun's energy you can actually see.



solar radiation - energy from the sun in the form of photons

You have probably heard the term **solar radiation** many times. Solar radiation can travel through empty space and materials like glass, air, and water. Can you see through glass, air, and water?

Put your arm in a sunbeam shining through the window. Can you feel your arm warming up? Feel the floor where the sun is shining. Does it feel much warmer than the floor which is in the shade? How does solar radiation heat things up? Solar radiation can only pass through things that you can see through. When solar radiation hits an object that you cannot see through, the energy is turned into heat. Some objects **absorb** solar radiation better than others. Some objects **reflect** solar radiation better than others.

absorb - to take in

reflect - bounce off or send back

Which objects and what colours are the best absorbers and reflectors of solar radiation?

Investigation: Absorber or Reflector?

In this investigation you will test different things to see which are the best absorbers and which are the best reflectors of solar radiation.

Materials You Need

- coloured paper (2 cm × 2 cm)
  - black
  - blue
  - red
  - white
  - any other colours you might have
- coloured pencils, pens, or crayons
  - black
  - blue
  - red
  - white
  - any other colours you might have
- aluminum foil (2 cm × 2 cm)
- black metal (refrigerator magnet, screwdriver, etc.)
- sunlight (Use a lamp with a 100 W bulb if it is a cloudy day.)

Steps to Follow

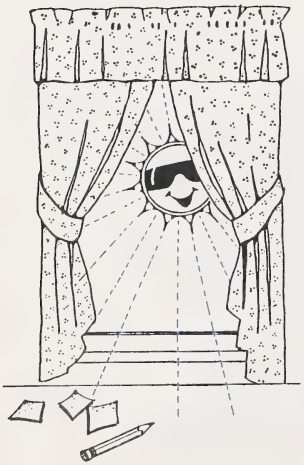
STEP A

Use your finger (a different one for each) to test the relative temperature of each substance. Record your results.

STEP B

Place the substances in a bright sunny area. The windowsill is a good place. Leave the items in the sunshine for about 5 minutes. Use your fingers (a different one for each) to test the relative temperature.

Observations



Substance	Colour	Starting Temperature	Temperature after 5 Minutes
paper or pencil	black		
	blue		
	red		
	white		
	any others		
aluminum foil	silver		
black metal	black		

Conclusions

1. Which colour is the best absorber of solar radiation?

_____

2. List the colours from best absorber to worst absorber of solar radiation.

_____

3. Which material is the best absorber of solar radiation (paper, aluminum foil, or black metal)?

_____

4. Explain why you think colour is important to the ability of a substance to absorb or reflect heat.

_____

_____

_____

_____

5. Where did the heat come from and how did it get to the substances in your experiment?

_____

_____

_____

All cars with antifreeze cooling systems have a radiator. This device transfers the heat of the engine to the surrounding air. What colour is the radiator in your car? Most likely it is black. Why is it black? Why is it called a **radiator**?

adiator - an object which is good t producing radiant energy

This next investigation will let you determine which colour is the best radiator.

Investigation: Which Colour Is the Best Radiator?

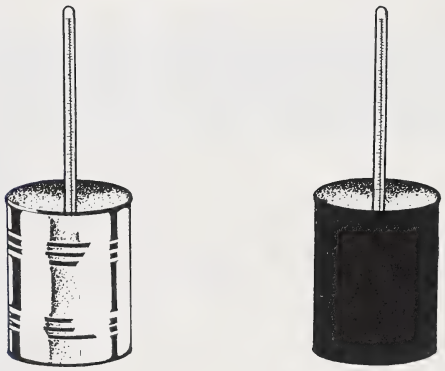
Materials You Need

- two identical empty tin cans with labels peeled off
- black paint
- two cardboard lids to fit over the cans
- thermometer
- clock or watch with a second hand

Steps to Follow

STEP A

Use the black paint to paint the outside of one of the cans. If you get any black paint on the inside of the can, be sure to clean it out. Set the can aside to dry (This may take overnight). Punch a hole in each of the cardboard covers to hold the thermometer.



STEP B

Run the hot water tap for a minute or so to get the hottest possible water. Fill the unpainted can with hot water and place it in a shaded spot on the counter. Cover the can with a cardboard cover and insert the thermometer. Wait until the thermometer reaches the highest temperature (it stops going up). Record this initial temperature and record the temperature every 3 minutes thereafter for at least 15 minutes.

OBSERVATION

Time	Temperature
0 minutes	
3 minutes	
6 minutes	
9 minutes	
12 minutes	
15 minutes	

STEP C

When the black paint is dry on the other can, run the hot water tap to get the hottest possible water. Fill the black can with hot water and place it in the same shaded spot on the counter. Cover the can with a cardboard cover and insert the thermometer. Wait until the temperature is the same as the starting temperature for the unpainted can in step B. Then record the temperature every 3 minutes for at least 15 minutes.

OBSERVATION

Time	Temperature
0 minutes	
3 minutes	
6 minutes	
9 minutes	
12 minutes	
15 minutes	

Conclusions

6. Which can (black or silver) had the lowest water temperature after fifteen minutes?

_____

7. Which colour is the best radiator?

_____

8. What appliances in your home use colour to keep heat in?

_____

_____

9. Which appliances in your home use colour to help get rid of extra heat?

_____

_____

Check your answers by turning to the Appendix, Section 2: Activity 4.

Have you ever seen a solar home? Perhaps you live in one. Solar heating uses the sun's radiated heat energy to heat the house. Solar heat is clean, since no waste products are produced. Solar heat uses no resources and will be available as long as there is sunshine. If solar heat is free and produces no pollution, why isn't everybody using it? Think carefully about the question. Solar heat is not free. The reason that there is a cold winter season is that there are fewer hours of sunshine and the sunshine is not as intense as it is in the summer. There must then be a large investment into the construction of a system to store and distribute the energy from the sun. Solar heat is really pollution free, though. The more solar heat you use, the less you pollute the atmosphere with carbon dioxide and other polluting gases. You also conserve ordinary fuels.

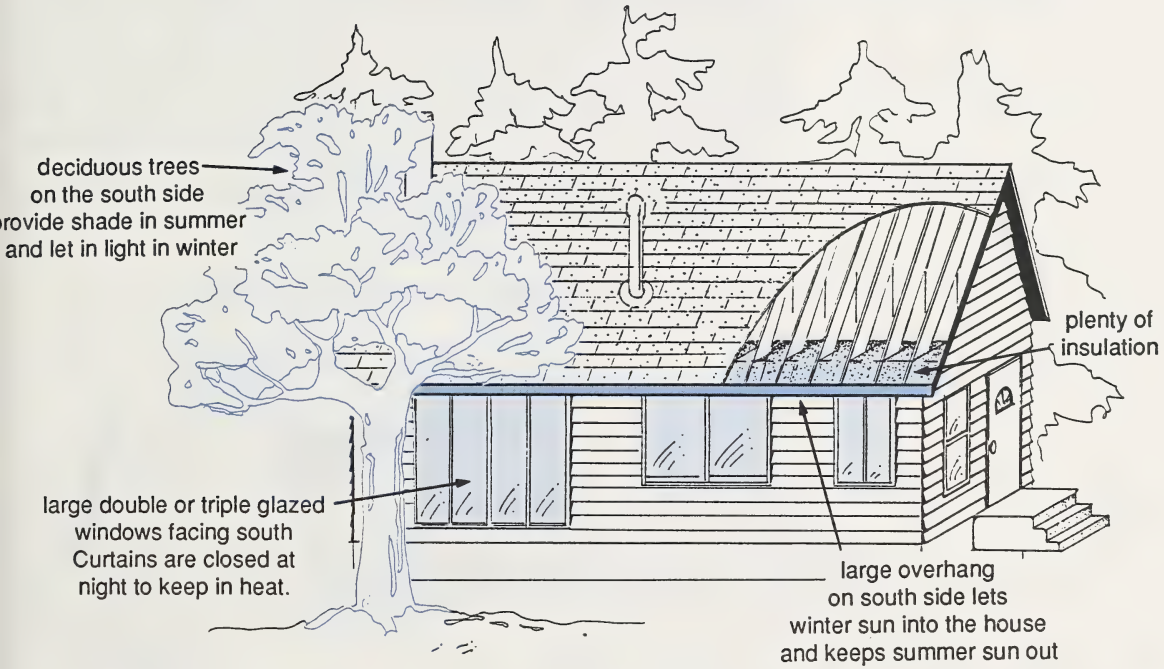
passive - not using any operating machinery

active - using operating machinery

There are two types of solar heating systems – **passive** and **active**. You will look at these two types in more detail.

Passive Solar Heating

Passive solar heating involves the overall design of the house to use solar heat. Look at the main aspects of construction and landscaping which provide the maximum use of solar energy through passive systems. They are illustrated in the following diagram.



10. What minor modifications could you make to your home to increase the amount of solar energy received in a passive way?

_____

_____

_____

11. In your climate, would passive solar heating provide all the required heat in the winter? Why or why not?

_____

_____

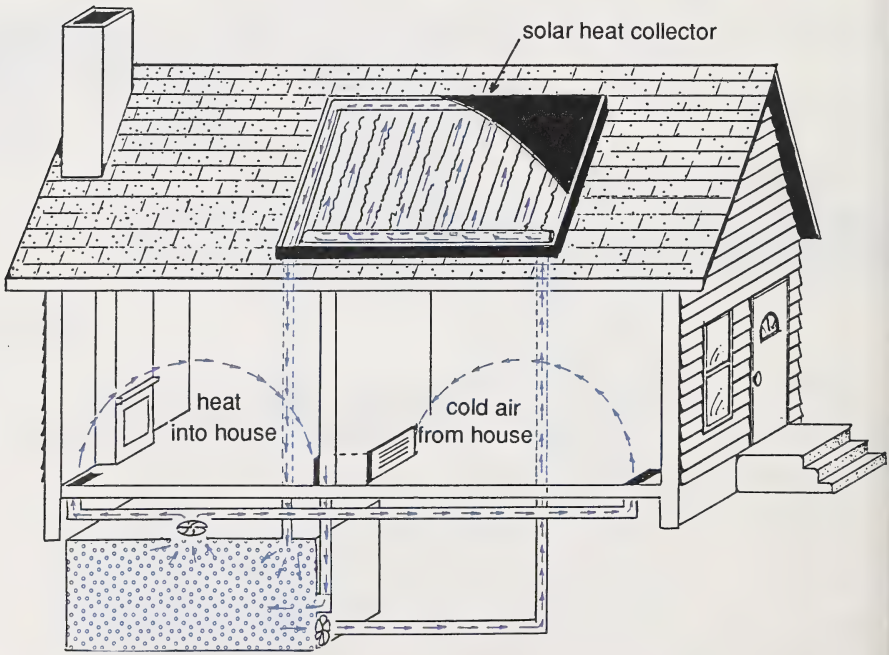
_____

You might wish to research more sophisticated ways to use passive solar heating in your home. The library and both federal and provincial governments are a good source of information.

Active Solar Heating

Active solar heating involves the use of specialized equipment to collect, store, and redistribute solar heat. Active solar heating requires relatively expensive construction and equipment. Thus, it is usually part of new home construction rather than an addition to existing homes. Insulation is very important in all parts of the house; ceiling, walls, windows, and doors. Why? Isn't solar heat free anyhow? No, it isn't free since electricity is required to circulate the fluids used to store and retrieve the heat. Also, northern climates do not receive much solar heat in the winter. It is not economical to waste heat or any resource.

Look at the following diagram of an active solar heating system.



(The pumps and motors have been left out to simplify the diagram.)

The storage space (containing water or small stones) can be as large as the entire basement. Can you imagine how expensive a system like this would be?

12. Assume that you are building an active solar heated home.

    a. Do you still need a conventional gas, oil, or electric furnace?

    _____

    _____

    b. What is one advantage of an active solar heating system, as compared to a passive system?

    _____

    _____

    c. What else could the active solar heating system be used for?

    _____

    _____

    d. What would happen if the electricity went off in winter?

    _____

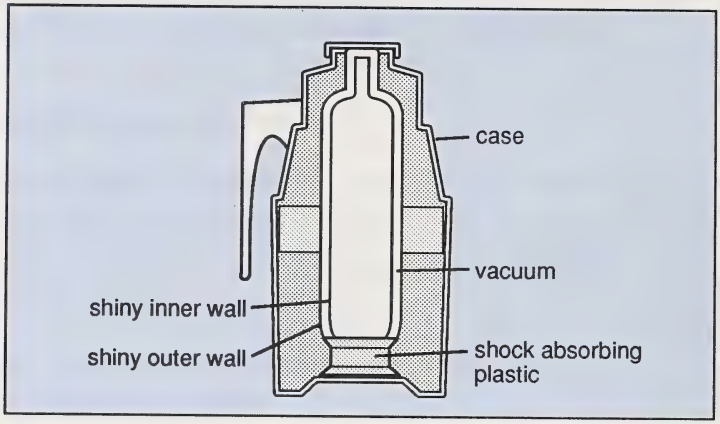
    _____

    e. What colour would you paint the solar collector? Why?

    _____

    _____

Have you ever looked closely at a thermos bottle? This is another device that is designed to take full advantage of the principles of heat transfer in order to keep the liquid inside cold or hot. The polished outer surface reflects heat from the outside, and the shiny inner surface traps heat that is trying to escape from the inside.



There is a vacuum between the inner and outer glass walls, so heat cannot pass between the inner and outer walls. It also has a plastic lid that will not allow heat to be lost easily. As a result, a thermos bottle can be used to keep hot things hot or to keep cold things cold.

13. Explain how the thermos bottle reduces each type of heat transfer.

    a. conduction

    _____

    _____

    b. convection

    _____

    _____

    c. radiation

    _____

    _____

Check your answers by turning to the Appendix, Section 2: Activity 4.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Section 2 discussed heat and heat transfer. You learned that

- household reactions either give off heat or take in heat.
- heat is transferred from warmer areas to colder areas.
- heat is transferred by
  - conduction
  - convection
  - radiation
- many household devices are designed to take advantage of the principles of heat transfer
- you have materials in your household to protect against heat transfer

Answer the multiple choice questions to check your understanding of heat, heat transfer and household devices, and the processes that involve heat transfer.

1. A chemical reaction that needs oxygen and a fuel to produce heat is

   a. conduction
   b. combustion
   c. corrosion
   d. acid-base

2. When a cold glass is held above a burning candle

   a. the candle flame goes out
   b. the glass gets water drops on the outside
   c. the glass cools down
   d. the flame burns brighter

3. If you open the outside door on your house when it is 22° C inside and −15° C outside, the heat flow will be from

   a. inside to outside
   b. outside to inside
   c. inside to inside
   d. outside to outside

4. A cup that has a hot liquid poured into it gets hot as well. This happens because heat is transferred by

   a. convection
   b. conduction
   c. radiation
   d. corrosion

5. The best spoon to use for stirring a hot liquid for a long time would have a handle made of

   a. stainless steel
   b. aluminum
   c. glass
   d. plastic

6. Water in an electric kettle is heated by

   a. conduction
   b. convection
   c. radiation
   d. both a. and b.

7. Radiation has occurred when

   a. spoons for stirring hot soup get hot
   b. currents cause water to get warm throughout
   c. the sun heats the inside of your car
   d. a propane barbeque cooks your steak

8. In convection, heat is transferred in

   a. solids
   b. fluids
   c. plastics
   d. metals

9. The best radiator of heat would be a

   a. black can
   b. grey can
   c. white can
   d. blue can

10. A substance that slows or limits the flow of heat is called a(n)

    a. radiator
    b. insulator
    c. conductor
    d. regulator

11. A convection current involves

    a. radiation through a vacuum
    b. moving gases and liquids
    c. solids touching
    d. light heating by absorption

12. Metals are good conductors because the molecules are

    a. close together
    b. far apart
    c. not present
    d. not moving

13. Heat transfer from the sun occurs by

    a. conduction
    b. convection
    c. radiation
    d. insulation

14. Solar houses take advantage of heat transferred from the sun to the house by

    a. convection
    b. insulation
    c. radiation
    d. conduction

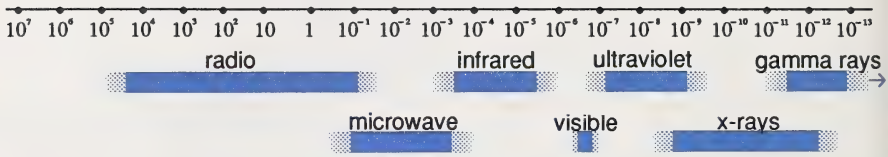
15. A thermos bottle works on the heat principles of

    a. conduction
    b. convection
    c. radiation
    d. all of the above

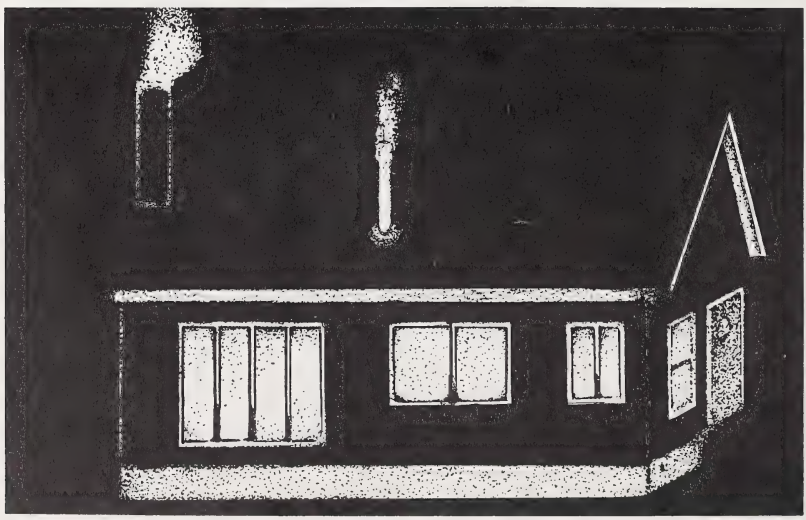
Check your answers by turning to the Appendix, Section 2: Extra Help.

Enrichment

Look at the following chart.



Notice that the visible part of the spectrum is only a small part of light from the sun. Human cannot see infrared light, but images can be seen using infrared photography. Cameras that use infrared film can capture an interesting picture of your house, your face, or your town. The warmest areas expose the film the most, the coldest areas the least. Look at the picture of the house. Where is most of the heat being lost? Where is insulation required?



Ultraviolet light is very dangerous to your eyes and is the leading cause of skin cancer. You can get a severe sunburn even on a cloudy day. Why is this so? You cannot see the untraviolet light which is causing your skin to burn. Low quality sunglasses can be worse for your eyes than no sunglasses at all! Why? The sunglasses reduce the amount of visible light reaching your eyes. Your eyes adjust by dilating (making larger) the pupils so more light gets to your retina. Low quality sunglasses also let in all of the harmful ultraviolet light which can seriously damage your retina. So be sure to buy sunglasses which block out most of the ultraviolet light.

1. Your senses pick up visible light (you detect it with your eyes) and infrared light (you feel it as heat with your skin). Explain why microwave, ultraviolet, x-rays, and gamma rays may be dangerous to you.

_____

_____

_____

_____

Check your answers by turning to the Appendix, Section 2: Enrichment.

Conclusion

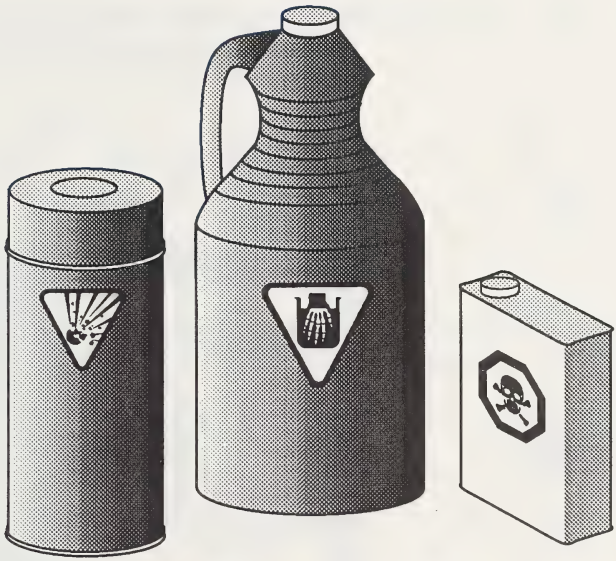
You have learned that many things that you do and use in and around your home involve heating and cooling. Heat is transferred from one thing to another in different ways. Many household devices use principles of heat transfer in their design and operation. Heat and heat transfer are essential to all life on this planet.

Assignment Booklet

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 2.

3 Household Products



When you work in the kitchen, bathroom, or garage, are you aware of the dangers of the products that you are working with? Cleaning products are good for getting the floor, laundry, oven, and dishes clean, but what happens if you do not use or store them properly? Is there someone in your house that is too young to read or who must be protected from harmful substances? Do you know what to do to help someone who has mistakenly used a product in the wrong way? When you prepare or put away food, are you aware of the potential dangers of improper storage and inadequate cleanliness?

In this section you will learn about the potential dangers of household products and processes. You will also examine household products to observe the safety precautions that are given on the labels and to determine what treatment is necessary if a product is used incorrectly.

Activity 1: Read the Labels

Why are manufacturing companies required to put labels on containers? Do you know what kind of information is included on a label? Consider a can of aerosol spray. You may reach for that can every day without really being aware of the potential dangers of the can or its contents. Do you know if there are special storage or usage requirements for that product? Many household chemical products are labelled with special symbols and warnings to tell you what kind of dangers they may present. Knowing and following these precautions may prevent an accident in your household.

Here is an example of how products must be labelled. Paint thinner is a solvent that must be used with care. The label tells the consumer how to use the product properly and what to do if first aid is required.

MAIN PANEL OF CONTAINER

USUALLY SIDE OR BACK PANEL OF CONTAINER

ABC

Keep away from open flame or spark.

First Aid Treatment: Contains petroleum distillates. If swallowed do not induce vomiting. Call a physician immediately.

Tenir loin de la flamme nue ou des étincelles.

Premiers Soins: Contient un distillat de pétrole. En cas d´ingestion ne pas faire vomir. Appeler immédiatement un médecin.

For this type of paint thinner two labels are required. A skull and crossbones in an octagonal frame means *Danger, Poison.* A flame in a diamond-shaped frame means *Warning, Flammable.* Remember, *Flammable* and *Inflammable* mean the same thing!

The hazardous product symbols show two things.

- The symbols show the **TYPE OF HAZARD** in a product.


Poison


Flammable


Explosive


Corrosive

- The frames show the **DEGREE** of that hazard (or, in other words, how dangerous the product is).


Danger

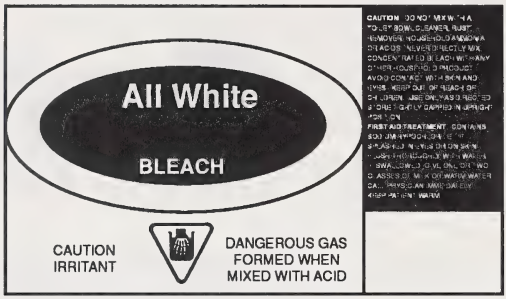

Warning


Caution

Here are the hazardous product symbols required by the Government of Canada to indicate if a household product is dangerous.

1. For each of the product labels given, explain what the symbol means. Include both the type and degree of the hazard.

a.



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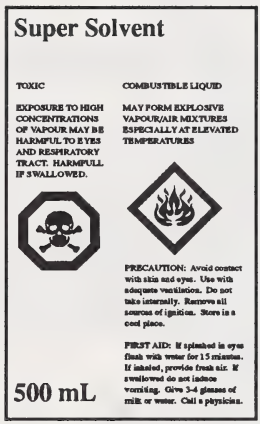
b.



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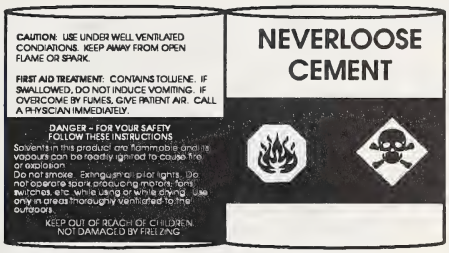

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e.

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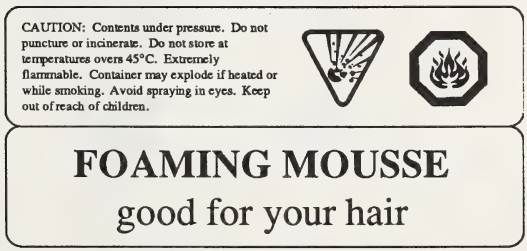

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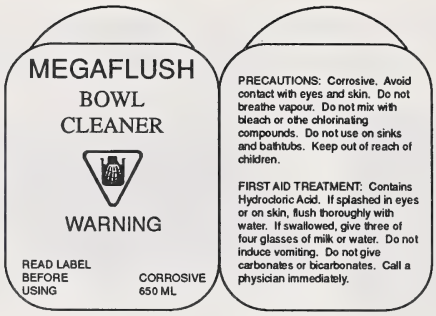
g.



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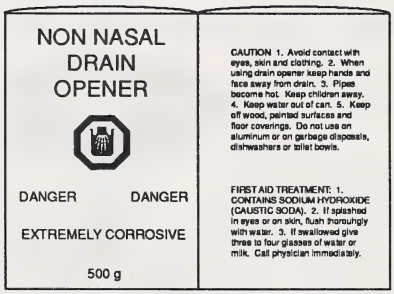
h.



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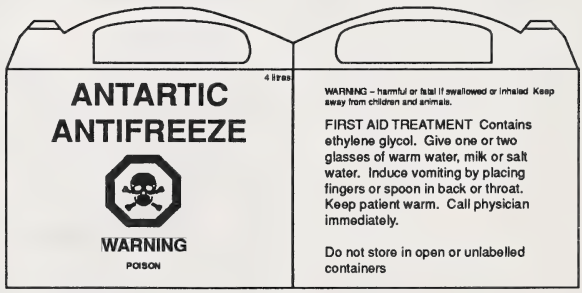
i.



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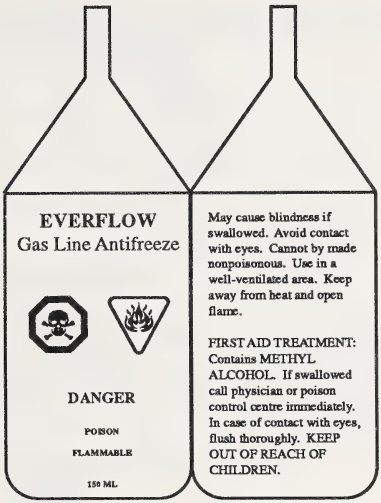
j.



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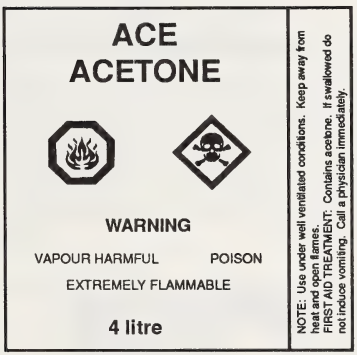

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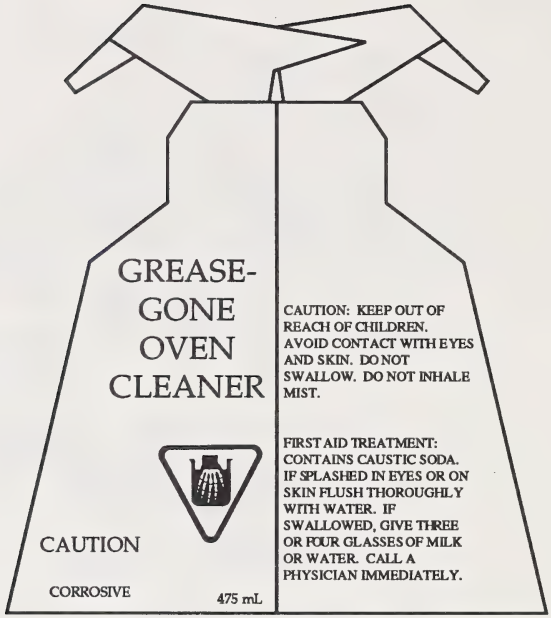
1.



Type: _____ Degree: _____

2. Why is it so important for household products to be labelled with hazardous product symbols?

_____

_____

_____

3. On which products given in question 1 are there cautions against heating?

_____

_____

_____

_____

4. Why are there storage suggestions on the labels of some dangerous household substances?

_____

_____

_____

_____

Product labels tell you a lot of things about the substance inside. So far you have looked at the hazardous product symbols for household products. Have you noticed that most of the labels also include an explanation of what to do if something goes wrong? Reading the labels is very important when using and storing household substances.

Check your answers by turning to the Appendix, Section 3: Activity 1.

Activity 2: What Happens If...? and How to Prevent It

You may be able to read the labels and understand what they mean, but what would happen if a young child accidentally took a household product and, not knowing better, drank it or inhaled the vapours? Every year the Government of Canada Poison Control Centre gets thousands of poisoning reports. Most of these poisoning cases involve children under the age of four years. The problems often occur because of improper handling and storage of products.

1. Look again at the labels given in question 1 of Activity 1. Most of them indicate a first aid treatment that can be given immediately if a product is used incorrectly or if it causes injury or illness.

   a. Why is it important to give immediate attention to someone who has used a product incorrectly?

   _____

   _____

   _____

   _____

   b. List the types of first aid treatments that are given on a product label.

   _____

   _____

   _____

   _____

   _____

Have you noticed that some of the first aid treatments recommend that you should not induce vomiting if a substance is swallowed. Often the substance is corrosive and will burn the victim's mouth and esophagus (food pipe) if it is swallowed. If the substance was vomited up again, it would do more damage as it came back up. Many labels suggest giving the victim milk or water instead.

2. What is the reason for giving a person who has swallowed a corrosive substance large amounts of milk or water?

3. Why do some labels caution against heating?

Some labels on household products caution against mixing with other substances. When the wrong things are mixed, a chemical reaction can occur, producing harmful substances. Mixing bleach with other household cleaners can have dangerous results. In some cases, the products produced are harmful enough to kill a person. The precautions listed on the label should always be taken seriously.

4. Read the labels on some cleaning products in your home. Which products caution against mixing?

Have a look around your house. Take note of where different household products are stored. Do the precautions on the labels of the products indicate proper storage procedures? Are the substances in your home stored in their proper places?

5. The following substances are stored dangerously. Suggest where or how they should be safely stored (especially if there are small children in the house).

a. drain cleaner under the kitchen sink

_____

b. turpentine by the furnace

_____

c. can of aerosol butane in the car

_____

d. an open bottle of bleach beside the washer

_____

e. an old, corroded car battery sitting in the garage

_____

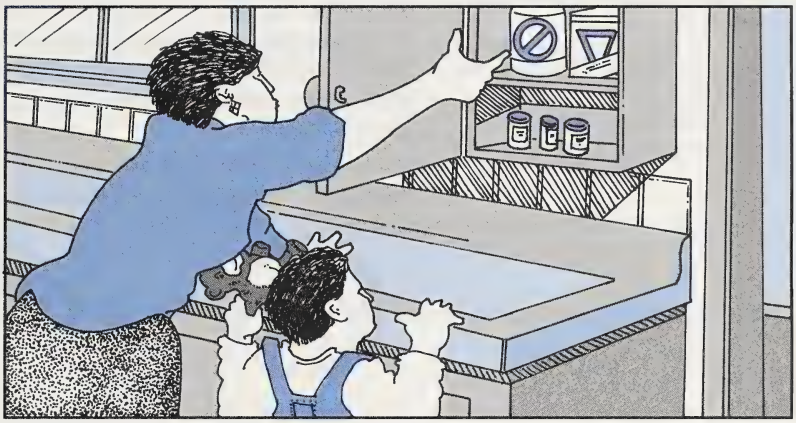
f. an open can of turpentine with a paint brush in it

_____

g. a medicine bottle (with the safety cap removed) sitting on the kitchen counter

_____

Safety and care when using and storing household products will reduce the chance of dangerous or harmful situations occurring in your home.



There are many different household chemical products. You must be careful to handle and use each one correctly. This means knowing what the hazardous product symbols mean and reading the label precautions.

You may think that if you read the labels and know and follow the precautions, nothing can go wrong. Wrong! Accidents can and do happen, but following safety instructions will greatly reduce the chances of such an accident.

insecticide - a poison used to kill insect pests

herbicide - a poison used to kill weeds or other plant pests

Most households have a variety of **insecticides** and **herbicides**. Insecticides are poisons used to kill insect pests. Herbicides are poisons used to kill plant pests (weeds). Are these poisons also harmful to people? Yes, they are! You can be harmed by swallowing, breathing in, and touching pesticides and herbicides. Always read and follow the instructions that are given on the label.

DANGER; POISON

This sign indicates a very dangerous pesticide/herbicide **high toxicity**

WARNING; POISON

This sign indicates a moderately dangerous pesticide/herbicide **moderate toxicity**

CAUTION; POISON

This sign indicates a low hazard pesticide/herbicide **low toxicity**

You will now work through the main ways in which accidental poisonings occur and learn how to prevent such accidents.

Poisoning by Mouth

This kind of poisoning usually occurs as a result of

- drinking the pesticide or herbicide
- getting the chemical in your mouth from contaminated clothes, hands, or equipment
- dust or spray getting into your mouth while applying the chemical

Preventative procedures include the following:

- Keep containers securely closed and labelled. Use original containers for storage. Never use kitchen tools or containers for mixing, measuring, or applying chemicals.
- Always wash all equipment, clothing, and hands after applying pesticides or herbicides.
- Use a respirator when applying chemicals. Never smoke while working. Mix chemicals outside, in a well ventilated area that is sheltered from the wind.

Poisoning through the Skin

This kind of poisoning usually occurs as a result of

- spills on the skin or clothing
- dust and spray settling on the skin while applying chemicals
- contact with equipment and containers which are contaminated with chemicals
- contact with plants and surfaces before the pesticide or herbicide has enough time to disperse or break down

Preventative procedures include the following:

- Wear rubber gloves and an apron while mixing and applying chemicals.
- Do not spray or apply chemicals on windy days and work with the breeze, not against it.
- Wash all equipment when finished.
- Stay out of the sprayed area (especially keep children out of sprayed areas) until the pesticide or herbicide has had enough time to disperse. Information about how long the chemical takes to disperse or break down should be on the label.

Poisoning by Breathing

This kind of poisoning usually occurs as a result of

- dust and spray being inhaled during the application of a chemical
- smoking contaminated tobacco

Preventative procedures include the following:

- Wear a respirator while applying chemicals and work with the wind at your back.
- Do not smoke or carry smoking supplies while working with pesticides or herbicides.

Storage of herbicides and pesticides is often a problem in households. Avoid buying more than you can use at one time so that you won't have to store the leftover chemicals. In fact, most herbicides and pesticides do not store very well. They deteriorate and become less useful with age. Dispose of containers and chemicals as specified on the container.

6. In each of the following identify what is wrong and explain what should have been done.

   a. A gardener used a pesticide on his cabbage. The unused pesticide was poured into a baby-food jar and stored in the shed.

   _____

   _____

   _____

   b. A woman sprayed a weed killer on her lawn on a windy day.

   _____

   _____

   c. A man was spreading a granular fertilizer on his lawn. Before he was finished, he went to eat supper without washing his hands or changing his clothes.

   _____

   _____

   _____

   d. A child was asked to spray some roses with an aerosol bug spray. The wind was blowing in the child's face as the roses were being sprayed.

   _____

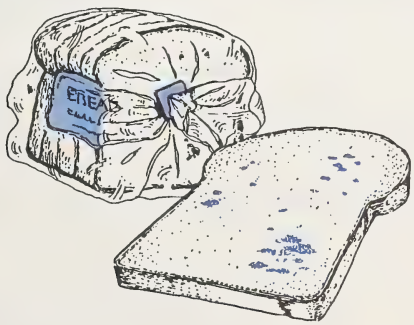
   _____

Check your answers by turning to the Appendix, Section 3: Activity 2.

Activity 3: Danger in the Kitchen

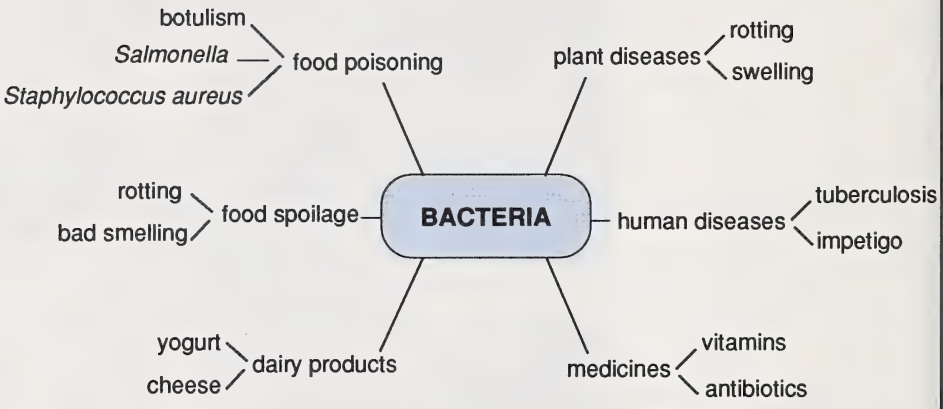
What did you think of when you read the title of this activity? By now you are probably thinking about all the cleaners, detergents, drain openers, and solvents that are potentially dangerous if used incorrectly. Did you think of food as well? Food can be dangerous and harmful, too – not because of the food itself, but because of what may be in the food.

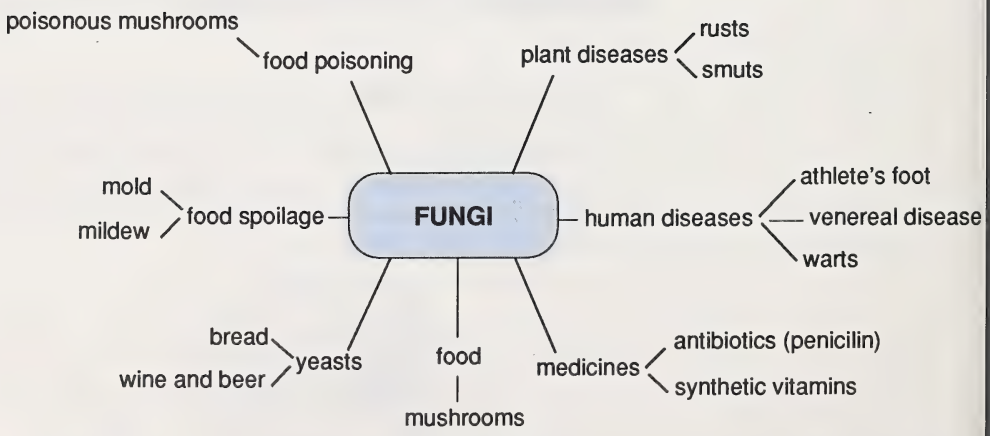
Have you ever been very sick after eating some food? What caused the illness? If you have a cold, do you make sure to cover your mouth and wash your hands when you cough? Have you ever caught a cold from someone that has been around you? Does the bread and cheese around your house go mouldy if you do not eat it fast enough? What causes bread to go mouldy?



Bacteria and fungi are small or microscopic living things. They are not able to produce their own food, like plants. They must have a food source in order to grow and reproduce. Some bacteria and fungi like the same kinds of food that you do. When bacteria and fungi contaminate your food, it is said that the food has spoiled. It often smells and tastes bad, and can also be poisonous. But, do you know that bacteria and fungi are also used to produce certain foods and medicines?

The following diagrams show some of the good things and some of the bad things for which bacteria and fungi are responsible.

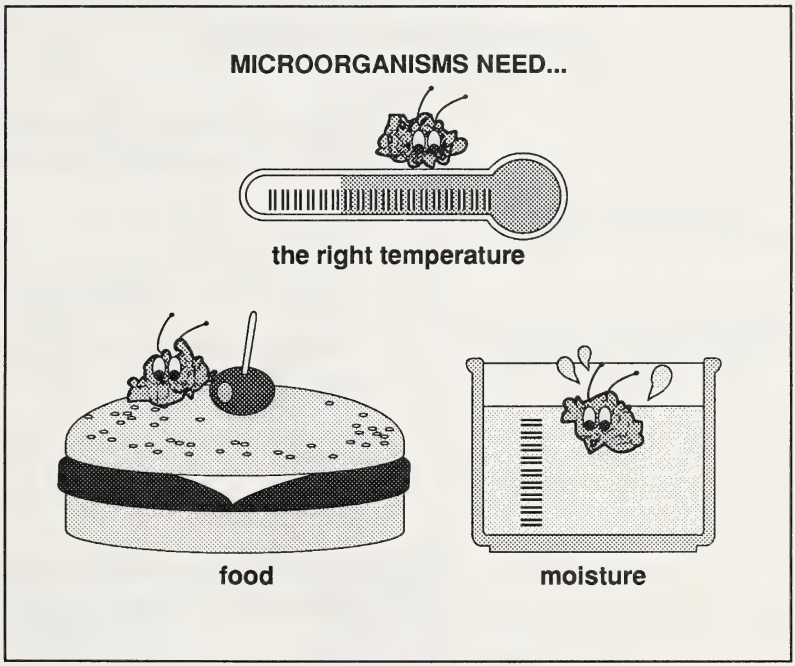




microorganisms - very small life forms including bacteria and fungi

Bacteria and fungi are often called **microorganisms**.

What kinds of conditions do microorganisms need to grow and reproduce? They need much the same kinds of conditions that you need.



If you want to stop or slow down the growth and spread of microorganisms in your kitchen, you can do a number of things.

- Kill the microorganisms by using cleaning chemicals or heating to extremely high temperatures.
- Dry the food so that the microorganisms do not have the moisture that they need to grow.
- Cook and seal the food.
- Reduce the temperature (keep food in the freezer or refrigerator).
- Remove the food source (keep all utensils, hands, and countertops clean).

1. What are the main problems that bacteria cause in the kitchen?

2. What are the main problems that fungi cause in the kitchen?

3. If you keep meat frozen in the freezer, it has little chance to spoil. What stops the microorganisms from growing?

4. How does cleaning the utensils, countertops, and the stove affect microorganisms?

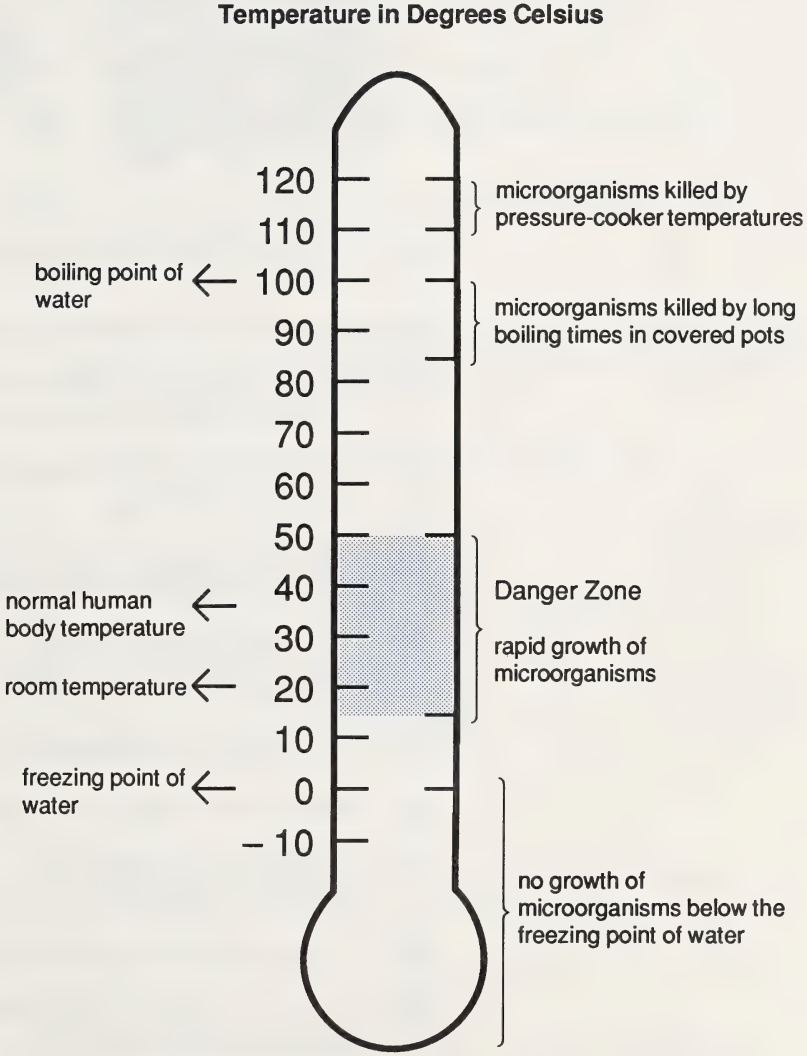
5. Dried foods are less likely to spoil than moist foods. What does this mean in terms of what microorganisms need to grow?

6. Why should you use soap and cleansers, rather than plain water, when washing your hands and cleaning the kitchen?

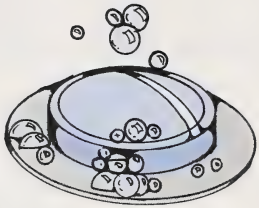
7. Freeze-dried foods are very popular with hikers and campers. Why do you think this is so?

Check your answers by turning to the Appendix, Section 3: Activity 3.

Temperature is very important to the growth of microorganisms. Very high cooking temperatures, such as those in a pressure-cooker, will kill microorganisms and their spores. Freezing will stop the growth, but will not kill most microorganisms. Look at the following diagram to see what effect temperature has on microorganisms.

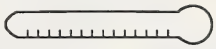


Food Handling in the Kitchen – Some Important Guidelines



1. Wash your hands before and often while handling foods in the kitchen.
2. Wear gloves if you have a cut or infection on your hands.
3. After using utensils or cutting boards or anything else with raw meat, scrub them with hot, soapy water before using them for anything else.
4. Thaw frozen foods on the lowest shelf in the refrigerator so they do not drip on other things.
5. Time your cooking so that hot foods can be served right away and cold foods can be kept in the refrigerator until just before serving.
6. Do not leave hot or cold foods out on the table after you have finished eating. Store them in the refrigerator as soon as possible. Cooked foods do not have to cool down before being put into the refrigerator.
7. Put hot foods in shallow dishes so that they cool down quickly.
8. Wash any dust and dirt off the tops of cans before opening them.
9. Do not use cracked, bulging, torn, or stained packages, partially defrosted frozen foods, or badly dented cans.
10. Avoid eating raw foods and drinking unpasteurized milk.
11. Do not can or preserve foods without reliable instructions from a cookbook or home economist.
12. Do not use the same kitchen towel for a lot of different purposes like wiping the dishes, wiping your hands, and cleaning the counter top. Have different ones for different purposes.
13. Clean kitchen appliances carefully. Get all the hidden places clean, too.

(14) Cook meats until they are at least 75° C in the centre.

(15) Keep your refrigerator at or below 7° C. 

(16) Do not use your hands to mix foods.

(17) Do not taste food with the spoon that you are cooking with without washing it first.

(18) Buy frozen foods last when you go shopping.

(19) Boil home-canned foods for at least fifteen minutes before eating them.

(20) Do not overload the dishwasher. Overloading prevents the dishes from being cleaned properly.

8. Here are some facts about microorganisms. In the space provided write the numbers of the food handling rules which match each fact. You may use more than one rule for each fact.

   a. Most food-poisoning bacteria like room temperatures.

   _____

   b. Some food-spoiling bacteria can live in the refrigerator.

   _____

   c. Bacteria live in towels and dish cloths.

   _____

   d. Microorganisms found in raw meat can get into other foods that touch places where the raw meat has been.

   _____

   e. Microorganisms are found everywhere – on your hands, on your skin, in your mouth, on countertops, on appliances, and in food.

   _____

f. It takes only a few microorganisms to cause problems.

_____

g. Cooked food which is left out will cool quickly, allowing microorganisms to start to grow.

_____

h. Microorganisms grow and reproduce very quickly.

_____

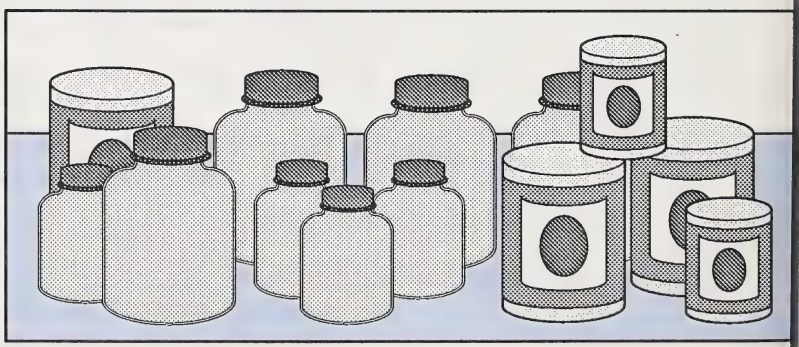
i. Microorganisms need food to grow.

_____

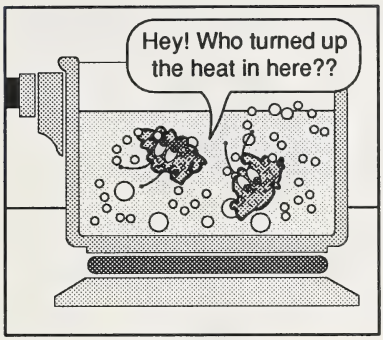
j. Most microorganisms and their spores are killed by boiling.

_____

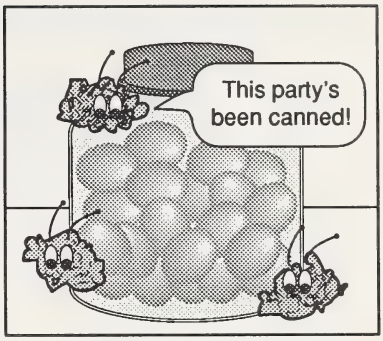
There are a number of ways that food is preserved by the food companies. They use high temperatures to cook the food, airtight containers to store and ship it in, and they add chemicals to preserve the food. All these methods kill microorganisms or slow down their growth so that the food will not spoil as quickly. The process of making potato chips uses all four methods of preservation.



Have you opened a can or jar of food lately? Canning is done both commercially and noncommercially to preserve food. Canning helps to preserve the food in two ways.



Heating destroys most microorganisms.



Sealing prevents microorganisms from entering the food.

You have learned that there are many ways that you can prevent food poisoning, but you have to follow the guidelines if you want to be safe in the kitchen.

9. List as many ways of preserving food as you can. Include methods used both by yourself and by the food companies.

_____

_____

_____

_____

Check your answers by turning to the Appendix, Section 3: Activity 3.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In Section 3 you learned about household products and safety in and around the home.

Household products are labelled with hazardous product labels, safety precautions, and first aid treatments.

1. Give the meaning of each label.

_____

_____

_____

_____

Careful storage of substances is important when using household products.

2. Complete each of the following statements.

   a. Keep explosive and flammable substances _____

   _____

   _____

   b. Keep poisonous substances _____

   _____

   _____

   c. Store medicines in _____

   _____

   _____

   d. Keep corrosive substances _____

   _____

   _____

Mixing substances can be dangerous if poisonous products result. Be careful to read the labels.

Microorganisms are tiny organisms, such as bacteria and fungi.

3. a. List three beneficial uses of microorganisms.

_____

_____

_____

b. List three harmful effects of microorganisms.

_____

_____

_____

Microorganisms have specific growth requirements.

4. List the three growth requirements of microorganisms .

_____

_____

_____

Microorganisms can be controlled by good food-handling practices. Harmful microorganisms can cause food spoilage and food poisoning.

Check your answers by turning to the Appendix, Section 3: Extra Help.

Enrichment

You may want to further investigate different types of food poisoning and their causes. Write a report on one of the following microorganisms that cause food poisoning.

- *Staphylococcus*
- *Salmonella*
- *Clostridium botulinum*

Include the following points in your report.

- What are the symptoms of the poisoning?
- How is the poisoning treated?
- What safety precautions would you follow to avoid this kind of poisoning?

Check your answers by turning to the Appendix, Section 3: Enrichment.

Conclusion

In this section you have learned that handling household products and food stuffs requires special care and attention. Safety labels provide you with information on household products – their use and storage – and food handling guidelines provide practical ways to use and store food in the kitchen. Awareness of special handling precautions will keep you safer around the house and in the kitchen.

Assignment Booklet

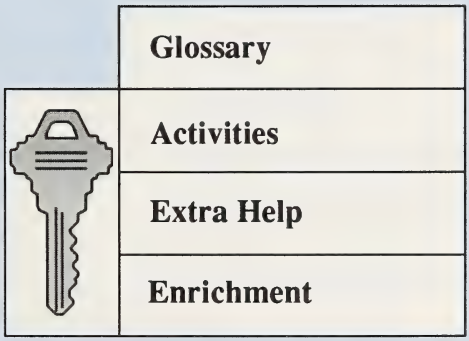
ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 3.

MODULE SUMMARY

In this module you discovered that acids and bases have properties that you can identify. The reactions of acids and bases can be useful or dangerous. You also learned that the reactions that happen in your house take in or give off heat, and that heat can be transferred by conduction, convection, or radiation. By examining household products and processes you learned that there are many substances, including food, that you should handle with special care and caution.

Appendix



Glossary

Absorb	• to take in
Active	• using operating machinery
Chemical reaction	• involves the breaking of bonds that hold molecules together and the production of new molecules
Combustion	• a rapid chemical reaction between a fuel and oxygen Heat and waste gases are produced.
Conduction	• the transfer of heat through a substance or from one substance to another when the substances are touching
Conductor	• substance which allows heat to be transferred
Convection	• the transfer of heat from one place to another by a moving gas or liquid
Convection currents	• movement of heated fluids where hot parts rise and cooler parts sink to take their place
Corrosive	• destroys human tissue
Fluids	• gases and liquids
Herbicide	• poison used to kill weeds or other plant pests
Indicator	• a chemical that changes colour in an acid or a base
Insecticide	• a poison used to kill insect pests
Insulator	• a substance which is a poor conductor of heat
Microorganisms	• very small life forms including bacteria and fungi
Neutral	• neither acidic nor basic
Neutralization reaction	• a reaction between an acid and a base where both the acid and base are made neutral (pH = 7)
Passive	• not using any operating machinery
pH	• a measure of how acidic or how basic a solution is

Photon	• unit of electromagnetic energy
Radiator	• an object which is good at producing radiant energy
Reflect	• bounce off or send back
Solar radiation	• energy from the sun in the form of photons
Vacuum	• space in which there is no matter
Water vapour	• water that is in the gaseous state Water vapour is also called steam.

Suggested Answers

Section 1: Activity 1

Investigation: Household Acids and Bases

Observations

STEP A	Name of Acid or Base	Appearance of Nail after 2 Days
Acids	lemon juice	rusty, corroded
	vinegar	rusty, corroded
	pickle juice	rusty, corroded
	cream of tartar	rusty, corroded
	aspirin	rusty, corroded
Bases	baking soda	shiny, unchanged
	antacid tablet	shiny, unchanged
	bleach	shiny, unchanged
	window cleaner	shiny, unchanged
	liquid soap	shiny, unchanged

STEP B		Taste
Acids	lemon juice	sour
	vinegar	sour
	pickle juice	sour
	cream of tartar	sour
	aspirin	sour
Bases	baking soda	bitter
	antacid tablet	bitter
	soap	bitter

STEP C

Substance	Litmus Colour	Acid or Base
lemon juice	red	acid
vinegar	red	acid
pickle juice	red	acid
cream of tartar	red	acid
aspirin	red	acid
baking soda	blue	base
antacid tablet	blue	base
soap	blue	base
bleach	blue	base
window cleaner	blue	base
liquid soap	blue	base

STEP D

Substance	Feel
lemon juice	sqeaky clean
vinegar	sqeaky clean
pickle juice	sqeaky clean
cream of tartar	sqeaky clean
aspirin	sqeaky clean
baking soda	slightly slippery
antacid tablet	slippery, chalky
soap	slippery
bleach	slippery
window cleaner	slippery
liquid soap	slippery

STEP E

Substance	Oil Dissolved (yes or no)	Substance	Oil Dissolved (yes or no)
lemon juice	no	antacid tablet	yes
vinegar	no	soap	yes
pickle juice	no	bleach	yes
cream of tartar	no	window cleaner	yes
aspirin	no	liquid soap	yes
baking soda	yes		

Conclusions

1. In general, acids taste sour and bases taste bitter.

2. Acids react more with metals than bases do. The iron nails are rusted and corroded in acids but are relatively shiny in bases.

3. Litmus paper turns red in acids and blue in bases.

4. Acids feel much like ordinary water. Some acids may have a squeaky feeling. Bases feel slippery.

5. Acids do not dissolve oils very well. Bases dissolve oils readily.

Section 1: Activity 2

1. No, weak bases, such as baking powder and some cleaners, do not have warning labels. Strong, corrosive bases, such as bleach, drain cleaner, and oven cleaner, have warning labels.

2. No, there are some bases which you can eat, such as antacids and baking powder. Some cleaners and detergents also are not harmful.

3. You should have seen some of the following:

4. Not all acids have warning labels. Lemon juice, vinegar and shampoo are some examples of those that do not. Strong corrosive acids, such as battery acid and hydrochloric acid, have warning labels.

5. No, many acids are used in food or food preparation, or for household use.

6.

7. Most cleaning products, such as soaps, drain and oven cleaners, and bleaches, are bases.

8. Most acids are found in food products such as citrus juices, vinegar, and cream of tartar.

Section 1: Activity 3

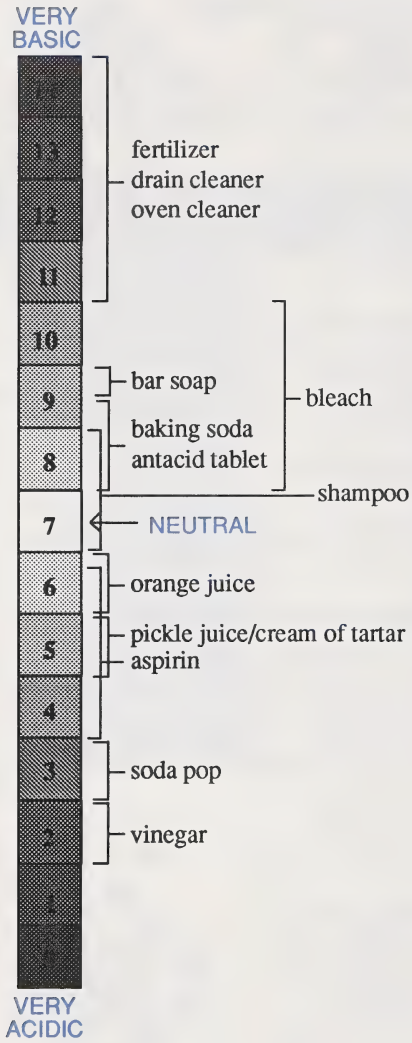
Investigation: Finding pH Values

Observations

STEP A

Substance	pH	Substance	pH
orange juice	6	baking soda	8-9
pickle juice	5	antacid tablet	8-9
vinegar	2	bar soap	9
soda pop	3	bleach	8-10
shampoo	7-8	fertilizer	11-14
cream of tartar	5	drain cleaner	11-14
aspirin	4-6	oven cleaner	11-14

Conclusion



1. The range is from 0 to 7.
2. The range is from 14 to 7.
3. The acid with pH = 1 is 10 000 times more acidic than an acid with pH = 5.
4. The base with pH = 12 is 1000 times more basic than the base with pH = 9.

Investigation: Concentrated and Dilute Acids and Bases

Observations

5. The pH of the concentrated vinegar is 2.
6. The pH of the diluted vinegar solution (25 mL vinegar + 250 mL water) is 3.
7. The pH of the diluted vinegar solution (25mL vinegar + 500 mL water) is 4-5.
8. The pH of the diluted vinegar solution (25 mL vinegar + 1 000 mL water) is 6-7.

STEP E

Solution	pH
25 mL cleaner	11-14
25 mL cleaner + 250 mL water	11-14
25 mL cleaner + 500 mL water	9-10
25 mL cleaner + 1000 mL water	7-8

Conclusion

9. Skin burn: Flush the skin immediately with lots of cold water. This will dilute and wash off the majority of the acid or base. Get the victim to a doctor immediately.
   Swallowed: Give the victim milk to drink (the acid or base will react with the milk instead of the body organs) and get the victim to a doctor immediately.

Section 1: Activity 4

1. Heat and new products are always produced when an acid reacts with a base.
2. An acid and a base react in a neutralization reaction.
3. The acid or base will react with the milk rather than the body organs. Water will simply dilute the acid or base and further damage will occur.

Investigation: Home Brew Indicators

Observations

STEP B

Solution	Colour	pH
vinegar	pink	2
baking soda	blue	8-9
drain cleaner	green	11-14

Conclusions

4. 2-11; it depends on the students' results.

5. You would not use natural juices to make commercial indicators because it would be very difficult to obtain consistent results.

Section 1: Follow-up Activities

Extra Help

1. F The investigation: Household Acids and Bases demonstrated that acids do not dissolve oils, fats, and grease.

2. T

3. F Bases taste bitter. Acids taste sour.

4. T

5. T

6. F It is a strong acid.

7. T

8. F Battery acid is strong.

9. F Not all acid-base reaction are useful.
10. F It is less than 7.
11. T
12. T
13. T
14. F The indicators change color.
15. T

Enrichment

Investigation: Antacid Effectiveness

Observations

STEP A

Antacid	Dissolving Time
Tablet A	varies (2-10 minutes)
Tablet B	varies (2-10 minutes)

1. The one which dissolves fastest would be the faster acting antacid.
2. Before phenolphthalein indicator was added, the solution was clear
3. After phenolphthalein indicator was added, the solution was pink

STEP C

Antacid	Drops of Acid
Tablet A	varies (2-10 drops)
Tablet B	varies (2-10 drops)

Conclusions

4. a. clear
   b. pink

5. The most effective antacid would be the one which dissolves the fastest and neutralizes the most acid. The discomfort you feel from heartburn is due to excess acid which needs to be neutralized.

6. One acid may be ten times more concentrated than the other. For example the pH of one acid might be 6 and the other might have a pH of 5.

7. Probably not. You must do more than one trial because the measurements are rather crude and more precise measurments are required. The more times you do the experiment the better.

Section 2: Activity 1

1. • heating your home
   • heating your water (for washing, showers, etc.)
   • drying clothes
   • cooking

2. a. The candle goes out a short while after it is covered by a glass because all of the oxygen under the glass is used up. No more oxygen can enter and the conbustion reaction must have oxygen to continue.

   b. The wind provides more oxygen for the fire, making it burn faster and hotter. Also, the wind will cause the fire to spread much faster than it would on a calm day.

   c. One of the products of the combustion of gasoline is water vapour. In the winter this water vapour condenses into a visible cloud, just as your breath causes a visible cloud of water vapour to condense. In the summer the water vapour does not condense and remains an invisible gas.

3. People used wood, animal fats, dried manure, and then coal for fuel.

4. The following list gives some of the possible answers.

- furnace
- wood stove
- gas clothes dryer
- gas water heater
- barbecue
- automobile
- outdoor camping stoves and lamps
- butane lighters
- propane torches
- butane haircurlers
- propane refrigerators
- natural gas cooking stove

Investigation: Heat Reactions

Observations

STEP B

OBSERVATION

You should discuss a variety of things about the flame such as shape, colour, heat, flickers, etc.

5. There is a flame, heat is produced, light is produced.

6. There was combustion in the match used to light the candle.

7. Water droplets form on the outside of the jar.

8. The water must come from the combustion gases.

9. Heat is another product of combustion.

STEP F

OBSERVATION

The candle continues to burn for some time. Eventually the candle goes out. The water level in the jar rises. Note: If the jar makes a good seal with the pan, the water may not rise. If this is the case, repeat steps E and F, but put a toothpick in the pan so that the jar will not sit flat on the pan.

10. There is enough oxygen in the jar to keep the candle burning for a while.

Conclusions

11. A fuel and oxygen are required for combustion to occur. You might also say that a flame or a spark is required before the combustion can start.

12. Carbon dioxide, water vapour, and heat are produced when combustion occurs. You might also mention that carbon monoxide, nitrous oxides, and other waste gases are also produced.

13. Fuel + Oxygen → Carbon Dioxide + Water Vapour + Heat

    The hot pudding transfers its heat to the refrigerator. The warmed up refrigerator then transfers the heat to the air in the kitchen. The warmed up air in the kitchen transfers the heat to the air conditioner in the kitchen window. The warmed up air conditioner transfers the heat to the air outside your house. Overall, the hot pudding transfers its heat to the air outside your home.

15. The iced tea solution is warmer than the ice cubes. This heat from the iced tea is transferred to the ice cubes, causing them to heat up and melt. This process will continue until the drink and the ice are the same temperature throughout (ice cold if there is still some ice left).

Section 2: Activity 2

1. Stoves, irons, pots and pans, water heaters, coffee pots, electric frying pans, and many other appliances transfer heat by conduction.

Investigation: Testing Conductors

Observations

STEP B

	OBSERVATION
wood	coldest
metal	hottest
plastic	in between

STEP C

	OBSERVATION
wood	coldest
metal	hottest
plastic	in between

Conclusions

2. Metal was the best conductor of heat.

3. Wood was the poorest conductor of heat.

4. The particles in a metal are closely packed together. Therefore, one particle can easily bump into its neighbours and transfer the heat. Wood and plastic have large, complex particles with more space between them. A particle will have less chance of bumping into its neighbours and transferring the heat.

5. Spoons, forks, and knives made of metal, pots and pans made of steel, copper or aluminium. Anything made of metals such as gold, silver, lead, steel, mercury, etc, are good conductors.

6. Anything made of wood, plastic, glass, wool, or cotton, is a poor conductor. Also, anything that traps air is a poor conductor of heat.

7. You would not be able to handle these pots and pans safely without the poor conductor.

Investigation: Testing Insulators

STEP A — OBSERVATION

Substance	Feeling
coin	cold
styrofoam	warm
aluminum	cold
wood	warm
paper	warm
wool	warm

STEP B — OBSERVATION

Substance	Feeling
coin	cold
styrofoam	cool then warm
aluminum	cold
wood	cool
paper	cool
wool	cool then warm

Conclusions

8. Styrofoam, wool, paper, and wood felt warmest.

9. Aluminum and the coin felt coldest.

10. Plastic, wood, cork, cloth (insulated oven mitts), fibreglass mats, rattan mats, etc, can all be used as insulators in your kitchen.

11. Some sources of information are encyclopedias, a dictionary of space technology, and texts on flight. In general, there are four types of tile used on the space suttle which range from high temperature (reinforced carbon) to lower temperature (Nomex felt). This is an overly simplistic explanation and you should read the complete explanations provided in other resources.

Section 2: Activity 3

Investigation: Convection Currents

Observations

STEP D **OBSERVATION**

The food colouring spreads out along the bottom and then it rises along the sides of the jar. Once the food colouring reaches the top, it moves to the centre of the jar and drops down to the bottom. Eventually the water is uniformly coloured.

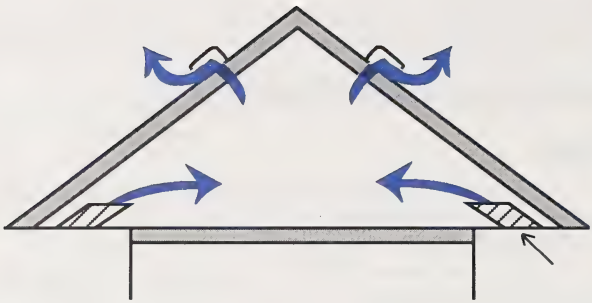
1.

Conclusions

2. A good place to see these currents is around a burning candle or a sunny spot on the floor. Smoke from a smouldering string or blown out candle is usually visible and will show the convection currents. Always be extremely careful with fire!

3. Ovens, furnaces, stoves and fireplaces, coffee makers, dishwashers, hairdryers, clothes dryers, and many others use convection as a means of heating.

4.



5. Convection is the transfer of heat by movement within a substance. The particles of gases and liquids are free to move, but the particles in a solid are fixed in place. Therefore, solids can only transfer heat by conduction.

Section 2: Activity 4

Investigation: Absorber or Reflector?

Observations

Substance	Colour	Starting Temperature	Temperature after 5 Minutes
paper or pencil	black	All colours should feel about the same at the start.	warmest
	blue		warm
	red		cooler than blue
	white		slightly warmer than at start
	any others		other colours will vary in general; the closer to black, the warmer; the closer to white, the cooler
aluminum foil	silver	cold	cold
black metal	black	cold	warm

Conclusions

1. Black is the best absorber of solar radiation.

2. The colours arranged in order from best absorber to worst absorber of solar radiation are black, blue, red, and white. The other colours will fit in between these as explained in the observations.

3. Black metal is the best absorber of solar radiation.

4. Black colours absorb more heat than all the other colours. The closer the colour is to black, the more heat it will absorb. White is the best reflector and the closer the colour is to white, the better it will reflect heat.

5. The heat came from the sun. The heat got to the substances from the sun by means of solar radiation.

Investigation: Which Colour Is the Best Radiator?

Observations

STEP D OBSERVATION
Results will vary due to different starting temperatures, size of can, and other variables. A decrease in the temperature should be observed.

STEP C OBSERVATION
Results will vary. There should be a greater decrease in temperature, as compared to the unpainted can.

Conclusions

6. The black can had the lowest water temperature after fifteen minutes.

7. Black is the best radiator.

8. Thermos bottles, space blankets, kettles, and any other silver or white, shiny appliances all use colour to keep the heat in.

9. Radiators in the car, refrigerators, deep freezes, and any other dark coloured appliances all use colour to help get rid of extra heat.

10. Increase insulation, keep the curtains open in daytime and closed at night, and plant deciduous trees (those that lose their leaves in winter) on the south side of the house. Other more major modifications may be mentioned.

11. The chances are that passive solar heating would not provide all the required heat in the winter. Northern climates receive little sun in the winter and the temperatures tend to be very cold.

12. a. Absolutely. During a cold spell, the energy provided by the active solar system may not provide enough heat.

    b. An active system can store heat when it is plentiful and release it at times when it is necessary.

    c. You can use it to heat water (for domestic use or for a swimming pool).

    d. The furnace and active solar heating systems would not function. Unless you have a wood stove or fireplace as a source of heat, the house will cool down.

    e. A solar collector should be painted black because black is the best absorber of solar radiation.

13. a. Conduction: The vacuum between the inner and outer walls prevents heat loss by conduction. Also, the cork or cup is usually made of hollow plastic.

    b. Convection: The vacuum between the inner and outer walls also prevents heat loss due to convection since there is no fluid to move.

    c. Radiation: The inner and outer walls are mirrored (painted silver) which makes them poor radiators.

Section 2: Follow-up Activities

Extra Help

1. b
2. b
3. a
4. b
5. d
6. d
7. c
8. b

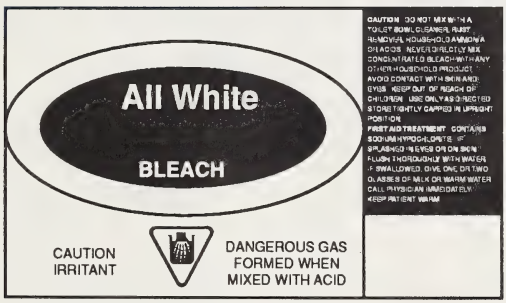
9. a
10. b
11. b
12. a
13. c
14. c
15. d

Enrichment

1. You have no senses to tell you that you are being exposed to radiation. Later, when your skin is burnt or when you suffer from some cancer or other illness due to the radiation, it is too late. As an analogy, imagine that you have no heat sensors in your skin. When you put your hand on the hot stove element, you feel no pain. The burn will be extremely bad if you leave your hand on a hot stove element for even a short time. Similarly, you can be exposed to ultraviolet radiation and not feel a thing. Later you will see the results as a serious sunburn.

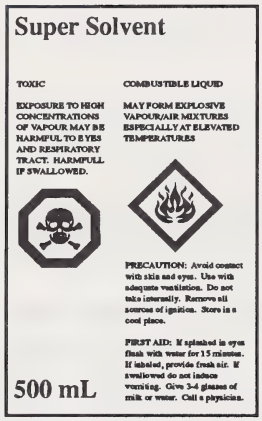
Section 3: Activity 1

1. a.



Type: corrosive Degree: caution

b.



Type: poison

Degree: danger

Type: flammable

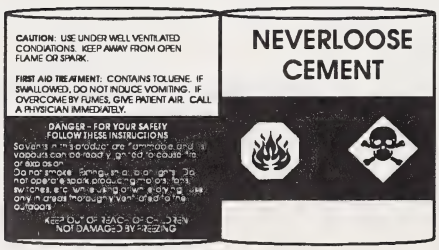
Degree: warning

c.

Type: poison

Degree: danger

d.



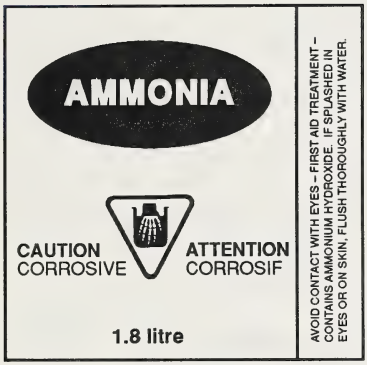
Type: flammable

Degree: danger

Type: poison

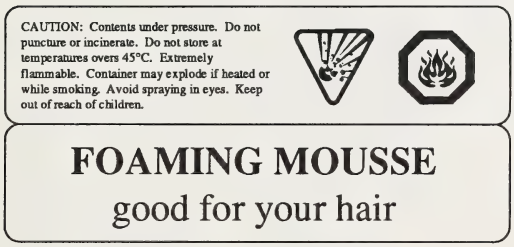
Degree: warning

e.



Type: corrosive Degree: caution

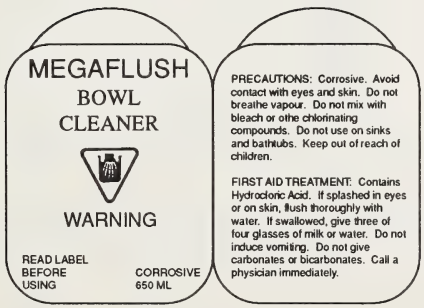
f.



Type: explosive Type: flammable

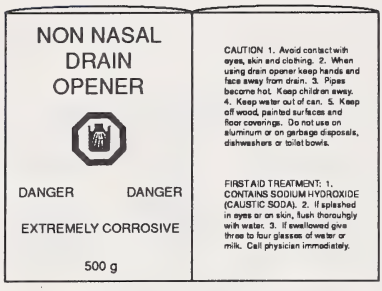
Degree: caution Degree: danger

g.



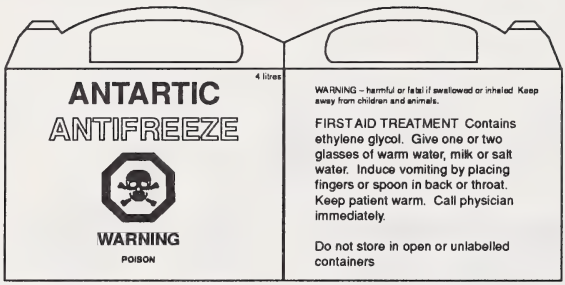
Type: corrosive Degree: caution

h.



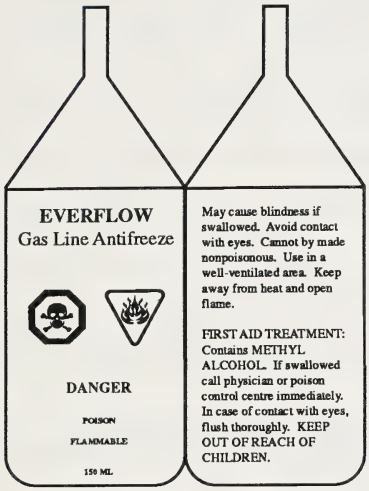
Type: corrosive Degree: danger

i.



Type: poison Degree: danger

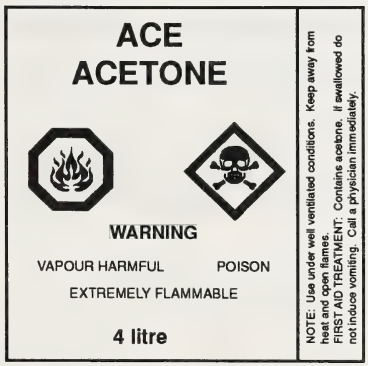
j.



Type: poison Type: flammable

Degree: danger Degree: caution

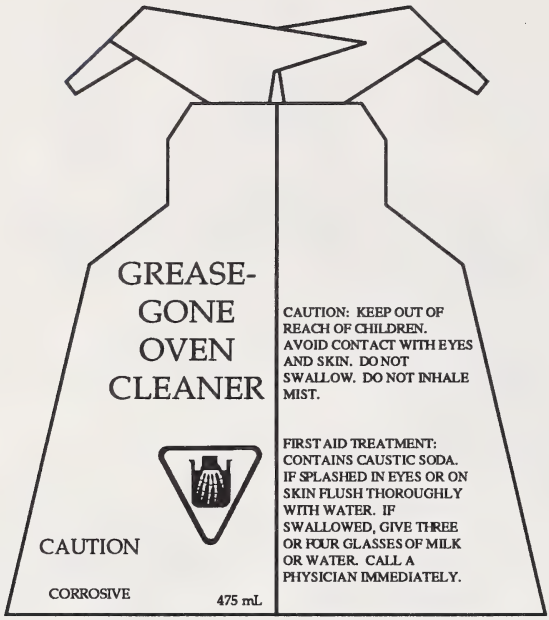
k.



Type: flammable Type: poison

Degree: danger Degree: warning

1.



Type: corrosive Degree: caution

2. If products are potential dangers it is important to know what to do to protect yourself and others.

3. Super solvent, Thinall paint thinner, acetone, Neverloose cement, foaming mousse, and gasline antifreeze

4. If products that are flammable or explosive are stored in hot places, they may catch fire or explode. Suggestions for storage help avoid potential dangers.

Section 3: Activity 2

1. a. If a product is swallowed or inhaled, the victim could die without immediate action. Also, physicians should be called because they can treat the victim properly.

   b.
   - If splashed in eyes or on skin, flush with water.
   - Do not induce vomiting.
   - Give milk or water.
   - Give patient air.
   - Induce vomiting.

2. Large amounts of milk or water will dilute the acid or base. The corrosive substance will react with the milk rather than the stomach walls.

3. Heating something flammable or explosive may cause the substance to ignite and burn uncontrollably or cause the container to explode.

4. Household bleach, toilet bowl cleaner, and others may caution against mixing.

5. a. Store in a high cupboard so that small children cannot reach the drain cleaner.

   b. Store in a cool place in a shed or garage. Store out of reach of small children.

   c. Store in a cool place so it will not overheat and explode.

   d. Store out of reach of small children. Bleach should also be stored with the lid on so that small children do not swallow or inhale it.

   e. Wear protective gloves and clothes to take the battery to a recycling depot. Your local garage may take the battery free of charge.

   f. Remove and clean the paint brush. Close the can of turpentine and store it out of reach of children.

   g. Replace the safety cap on the medicine bottle and store in a locked cabinet.

6. a. The unused pesticide should have been stored in the original container. Chemicals should never be stored in different containers, especially food containers.

   b. She should not spray on a windy day. The wind can carry the herbicide to areas where it is not wanted, to a neighbours home, or onto other people.

   c. He should wash his hands and change his clothes before eating. He should also finish the job of spreading the fertilizer, clean up all the tools that he used, store the unused herbicide, ensure the clothes that he was wearing get washed immediately by themselves, and have a shower.

   d. The child should not have been spraying the bug spray – an adult should have been doing the spraying. Never spray into the wind, as the chemical gets blown back into your face and onto your clothes.

Section 3: Activity 3

1. Bacteria cause food spoilage and food poisoning. Human diseases can also be transmitted through tainted food and utensils.

2. Fungi mainly spoil foods and produce mildew in the kitchen. There are poisonous mushrooms which will cause illness or death. Eat only mushrooms that you are sure are safe to eat.

3. Improper growing temperatures stop microorganisms from growing.

4. Cleaning (especially with detergents) will remove the food that microorganisms feed on and will also remove or destroy the microorganisms.

5. Microorganisms need water to grow. Dried foods can be kept for very long periods of time, as long as they are not allowed to get wet.

6. Soaps and cleaners will actually kill many microorganisms. Plain water will not kill the microorganisms.

7. Freeze-drying foods produces a nutritious, lightweight, and very safe food. Freeze-dried foods are packaged in sealed packages and will keep for very long periods of time.

8. a. 4, 5, 6, 7, 14, 15, 18
   b. 10, 13, 18
   c. 12
   d. 3, 4, 10, 12
   e. 1, 2, 3, 8, 12, 13, 16, 17, 20
   f. 6
   g. 4, 5, 6, 7
   h. all the rules
   i. 4, 5, 6, 8, 9, 12, 13
   j. 14

9. Lists should include freezing, canning, drying, and using chemical preservatives. More sophisticated methods may include vacuum packaging, irradiation, and pressure cooking.

Section 3: Follow-up Activities

Extra Help

1.

danger; poison

caution; corrosive

warning; flammable

warning; explosive

2. a. in cool places away from sparks and flames.
   b. tightly closed and in cupboards that are out of the reach of children.
   c. locked cupboards.
   d. out of reach of children.

3. a.
   - dairy products
   - medicines
   - foods

   b.
   - food spoilage
   - food poisoning
   - plant and human diseases

4.
   - moisture
   - food
   - favourable temperatures

Enrichment

POISON	SYMPTOMS	TREATMENTS	PRECAUTIONS
Salmonella Bacteria that are multiplying in the body (stomach and intestines) make the patient ill.	Symptoms, usually begin twelve to fourty-eight hours after eating the infected food. The victim usually experiences vomiting, cramps, nausea, diarrhea, and sometimes headache and fever. Severe cases may also experience shock, dehydration, and kidney failure. *Salmonella* is the most frequent cause of mass poisonings.	Bed rest is required. No food or drink should be given until vomiting and nausea stop, and then only light tea and soup should be given. If vomiting continues, a salt solution to prevent dehydration should be given intravenously by medical personnel.	Any food which tastes or smells abnormal should be avioded. *Salmonella* is found on almost all the foods that you eat. It is important that foods are cooked thoroughly or eaten while they are fresh.

POISON	SYMPTOMS	TREATMENTS	PRECAUTIONS
Staphylococcus These bacteria multiply in food and produce a toxin (poison). These toxins, not the bacteria, are responsible for making people sick.	Symptoms usually begin two to four hours after eating the infected food. The victim usually experiences nausea, vomiting, cramps, diarrhea, and sometimes sweating and excessive salivation. In severe cases, there can be prostration, shock, and blood and mucus in the stools.	The victim requires bed rest and easy access to a bathroom. No food or drink should be given until vomiting and nausea stop. Light tea, light soup with salt, and thin cereal should then be given. Proper medication is required if vomiting and nausea persist.	Any person who is infected with *Staphylococcus* must not handle food. It takes only four hours for the infected food to produce enough toxins to be poisonous. Cooking kills the germs, but does not affect the toxins. Refrigerate all foods at or below 5°C.

POISON	SYMPTOMS	TREATMENTS	PRECAUTIONS
Clostridium botulinum These bacteria multiply in food and produce one of the most poisonous substances known. (One drop can kill 50 000 people). Botulism occurs most often in preserved foods.	Symptoms begin eighteen to thirty-six hours after eating the contaminated food. The victim experiences fatigue, dizziness, blurred sight, cramps, nausea, and vomiting. Muscles are also weakened, making breathing, swallowing, and speaking very difficult. Death results from inability to breathe or heart failure.	Medical attention is required immediately. The victim's stomach is usually washed and pumped out. The intestines are also flushed, using an enema. The patient is kept in bed in a darkened room and is fed intravenously. A respirator might be also necessary.	Eat fresh foods rather than canned foods. Boil any food of which you are uncertain. Ensure that you know exactly what you are doing when canning your own food.

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